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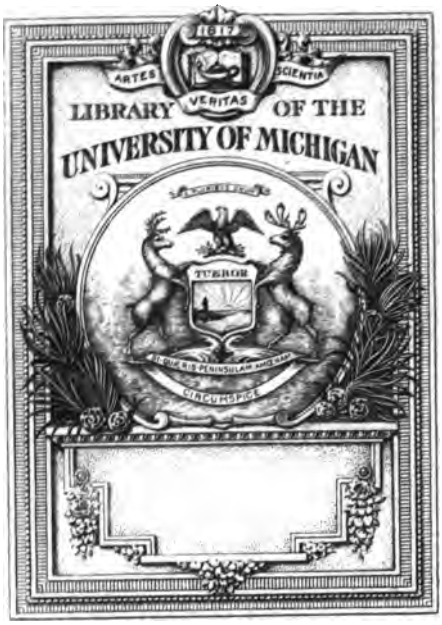

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TRANSACTIONS

OF THE

FIFTH ANNUAL MEETING

OF THE

Kansas Academy of Science

(1872)

WITH REPORTS OF THE SECRETARY.

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ORGANIZATION AND HISTORY.

By JOHN D. PARKER, Secretary.

In a general sense science is restricted to what is certainly known. The boundaries have been well ascertained, the general features mapped out, and the territory is clearly defined. In a more specific sense, science observes the phenomena of things, produces in experiments results not ordinarily occurring in nature,—inducts facts, deduces truths, collects general principles, and arranges them in systematic order.

The scientific *method* of the present age is different from that of the past. The ancient logic is fruitless as a means for the discovery of truth. The inductive philosopher of the present age collects all the facts of his subject, classifies them into tables, expunges those that are not significant, gathers the vintage, scrutinizes with respect to true value and import, illustrates if practicable by actual experiment, discovers the laws of phenomena, and rises in his knowledge, from one generalization to another, until all the facts crystallize into one comprehensive system.

The scientific *spirit* of the present age simply inquires, "What is truth?" Truth is to be found at all hazards, and bought at any price. All known things are to be laid under contribution. New appliances are to be constructed, and new methods of analysis invented, until we stand, if possible, face to face with the absolute.

The scientific spirit of the present age is also liberal. Its faith is as large as the universe. All things are believed possible until proved impossible; all things are believed true until proved untrue. Nothing is to be rejected that stands the touchstone of observation, comparison and experiment.

The scientific spirit of the present age is also fearless. All truth must be consistent with itself. No two facts of the universe can contradict each other. No two laws of the universe can disprove

each other. Scientific men are, therefore, willing to follow whithersoever truth may lead them. The most venerable errors of the past, however cherished and embalmed in the human heart, are to be destroyed. The most sacred shrines of the old world are to be desecrated, the idols of the temple of science to be thrown down, and the foundations of the temple itself to be removed. Science lays its fearless hand even on revelation itself, and gives it a new interpretation.

The *results* of inductive scientific investigation are almost beyond belief. Our respected ancestors, only three or four centuries ago, were little better than barbarians. The darkness of that period is profound and painful. "Out of that darkness and chaos," says a recent writer, "have come all our civil and religious freedom, all our philanthropy and benevolence, all our diffused comfort and luxury, most of our good manners and morals, and all the splendid achievements of our modern scientific investigation." As the inductive philosopher seated himself before the chaff heaps of antiquity to winnow out the grains of truth, a mighty task was laid upon him. Every premise must be thoroughly established, every observation re-observed, every experiment reconducted, and every comparison recollected. Nothing less than a new creation lay before him. Well may the works of the great founder of the inductive philosophy be christened *Novum Organum* and *Instantatis Magna.*

Moved by the impulses of the age, a few naturalists in 1867 resolved if possible to effect an organization for the cultivation of science, particularly in its relation to the State of Kansas. Kansas occupies an important field in its scientific aspects. The scientific marvels of our age flow out of associated effort. Scientists need opportunity to compare results and effect exchanges. They need to be inspired to go forth into the fields of nature by the presence of other explorers.

After considerable correspondence among the naturalists of the State in reference to the possibility of effecting such an organization, a letter was published in the Kansas *Journal of Education* for March, 1868, calling attention to the benefits of such a society and the necessity of effecting an organization at an early day. The publication of this letter met with such favor and called forth so many responses from the friends of science throughout the State, that the following "call" was issued in July of the same year :

"STATE NATURAL HISTORY SOCIETY.

"We, the undersigned, desirous of securing the advantages arising from association in scientific pursuits, and of giving a more systematic direction to scientific

research in our State, do hereby invite all persons in the State interested in natural science to meet at Topeka on the first Tuesday of September next, at 3 P. M., at the college building, for the purpose of organizing a State Natural History Society.

JOHN FRASER,	G. F. CHAPIN,
D. H. ROBINSON,	J. H. CARRUTH,
B. F. MUDGE,	R. D. PARKER,
J. A. BANFIELD,	JEFF. ROBINSON,
J. S. HOUGHAM,	PETER MCVICAR,
J. D. PARKER,	F. H. SNOW,
R. A. BARKER,	J. S. WHITMAN,
D. BROCKWAY,	RICHARD CORDLEY,

J. R. SWALLOW."

Pursuant to this call, a meeting of the naturalists of the State was held in Lincoln College, Topeka, Kansas, September 1st, 1868. On mature deliberation and thorough discussion, an organization was effected under the name of the Kansas Natural History Society.

At the third annual meeting of the Society, held in the University building at Lawrence, on the 5th and 6th of September, 1870, President John Fraser suggested that the scope of the Society be enlarged to comprehend the whole field of science within the borders of the State.

On motion, Messrs. John Fraser, F. H. Snow, D. H. Robinson, Frederick W. Bardwell and John D. Parker, having been appointed a committee on enlargement of the scope of the Society, made the following report, which was adopted:

WHEREAS, The unexpected success of this young Society, as at present organized, has awakened in many the desire to have its scope enlarged so as to embrace in its membership observers and investigators in other lines of scientific inquiry; and,

WHEREAS, It appears to us that such a change in our organization is calculated to promote the interests of science, and thereby the higher interests of our State; therefore,

Resolved, That the name and scope of our Society be so changed as to include every line of scientific exploration and observation conducted by residents within our State.

At the fourth annual meeting, held in the rooms of the Board of Education at Leavenworth, on the 25th and 26th of October, 1871, the Constitution and By-Laws were so amended as to embrace in the membership of the Society observers and investigators in every line of scientific inquiry; and the name of the Society was changed from the Kansas Natural History Society to the Kansas Academy of Science.

PROCEEDINGS OF THE SOCIETY.

The first annual meeting of the Society was held in Lincoln College, Topeka, Kansas, September 1st, 1868. After mature deliberation and thorough discussion, the association was organized, and the following officers were elected for the current year:

B. F. Mudge, President; J. S. Whitman, Vice-President; John D. Parker, Secretary; Frank H. Snow, Treasurer; John A. Banfield, Curator.

The second annual meeting of the Society was held in the Presbyterian church, Topeka, Kansas, September 7th, 1869.

The following papers were read:

On the Internal Heat of the Globe, by B. F. Mudge.

On Solving the Higher Equations, by Edward Cave.

A public lecture was delivered on the Mound Builders, by John D. Parker.

The officers of the previous year were re-elected.

The third annual meeting of the Society was held in the University building, at Lawrence, on the 5th and 6th of September, 1870

The following papers were read:

On the Plants of Kansas, by James H. Carruth.

On the Fishes of the Kansas River, as observed at Lawrence, by Frank H Snow.

On the Internal heat of the Earth, by John D. Parker.

On the Comparison of the Coals of Kansas with other Western Coals, by Wm. H. Saunders.

On the Saurian Formation of Kansas, by B. F. Mudge.

On the Moss Agate Formation of Kansas, by B. F. Mudge.

The following public lectures were delivered:

On Aims, Organization and Advantages of Scientific Associations, by John Fraser.

On Hugh Miller, or the Workingman's Education, by John H. Barrows.

The following officers were elected for the current year:

John Fraser, President; B. F. Mudge, Vice-President; John D. Parker, Secretary and Librarian; Frank H. Snow, Treasurer; B. F. Mudge and Frank H. Snow, Curators.

The fourth annual meeting of the Society was held in the rooms of the Board of Education, at Leavenworth, on the 25th and 26th of October, 1871.

The following papers were read:

On the Plants of Kansas, (continued from last year) by James H. Carruth.

On the Birds of Kansas, by Frank H. Snow.

On the Burlington Gravel Beds, by John D. Parker.

On the Darwinian Theory, by John Wherrell.

On some rare forms of Crystallization of Gypsum, by B. F. Mudge.

On the Red Sandstone of Kansas, by B. F. Mudge.

The following public lectures were delivered:

On the claims of the Natural Sciences, by Frank H. Snow.

On the Geology of Kansas, by B. F. Mudge.

The following officers were elected:

John Fraser, President; B. F. Mudge and Robert J. Brown, Vice-Presidents; John D. Parker, Secretary; F. H. Snow, Treasurer; B. F. Mudge and F. H. Snow, Curators.

The fifth annual meeting of the Society was held in the Congregational church, at Manhattan, on the 8th and 9th of October, 1872.

The following papers were read:

On the Peculiarities of the Cherokee Language, by D. H. Robinson.

On Ventilation, by Colonel William Tweeddale.

On the Plants of Kansas, (continued from last year) by James H. Carruth.

On two varieties of Limestone from Junction City, by William H. Saunders.

On two varieties of Coal from Colorado, by William H. Saunders.

On the Birds of Kansas, (continued from last year) by Frank H. Snow.

On the Geology of the Arkansas Valley, by B. F. Mudge.

On the Relation of Light to the Quantity of Gas Consumed, by F. E. Stimpson.

On the Remoteness of the Final Catastrophe, by John D. Parker.

On what is Good for an Artist, and what an Artist is Good for, by Miss Lizzie J. Williams.

On the Sources of the English Language, by J. H. Lee.

On the National Park, by Joseph Savage.

A public lecture was delivered on the Agreement of the Bible with Geological Science, by Rev. Charles Reynolds, D. D.

The officers of the previous year were re-elected.

The following commissions were confirmed for the current year:

B. F. Mudge, Geology; F. H. Snow and Edwin A Popenoe, Entomology; D. H. Robinson and J. H. Lee, Language; F. W. Bardwell, Engineering; F. E. Stimpson, Physics; John Fraser, Astronomy; J. H. Carruth, Botany; John Wherrell, Mineralogy; William H Saunders, Chemistry; John D. Parker, Meteorology.

The next annual meeting of the Society will be held at Lawrence at the call of the Executive Committee.

CATALOGUE OF PLANTS SEEN IN KANSAS.

BY J. H. CARRUTH.

With additions by Prof. F. H. Snow and Prof. E. Hall.

It is with great reluctance that I present this catalogue of the plants of Kansas, because it is so incomplete, even for Douglas county. I hope, if spared, to add more names to it.

Kansas is out of the field of both Wood and Gray, and I find plants that are not in either of their books. I have then to resort to Eaton of forty years ago, or to send plants to some one who can enlighten me. I have several such cases now on hand. I find plants corresponding partially, but not entirely, to descriptions in the book, and then I am in doubt whether they are varieties, or distinct species not in the book.

Botanists seem not to have finished arranging species into their appropriate genera; consequently the same plant has different names in different books. I shall use the names in Wood's Botanist and Florist, presuming that they are according to the most recent decisions.

Botanists are not agreed, or, if they are, it is but recently, as to whether plants with certain marks are species or only varieties. In such cases, I shall give the name, and, perhaps, my opinion.

The botany of Kansas differs considerably from that of New England and New York. Having no peat bogs, we lack the side-saddle flower, and all plants peculiar to such places. Having but little sandy land, we have few plants peculiar to that kind of soil. So far as I know, the whole large order Ericaceæ, including the huckleberry, cranberry, checkerberry, spoon-wood, pinxter and rosebay, is entirely wanting.

The Coniferæ, including the pines, spruces and cedars have but one representative, the Red Cedar, and that is rare.

The Betulaceæ, including the birch and alder are wanting.

In the order Cupuliferæ, which includes the oak, the beech and the chestnut are wanting.

The splendid magnolia and tulip tree, common farther east and south, are not found here.

The large orders Malvaceæ, including the hollyhock; Cruciferæ, including cabbage and mustard; Orchidaceæ, including the wild Lady's Slipper; and Cyperaceæ, including sedges and other grass-like plants with triangular stems, have but few representatives.

Ferns, mosses and lichens, (such mosses, so called, as grow on rocks and rails,) are rare, and ground pines are wanting; fungi are not common, though I have seen specimens of the puff-ball family four or five inches in diameter.

On the other hand, the Leguminosæ, including the pea and clover; the Compositæ, including asters, golden rods and sunflowers; and the Gramineæ or grasses are well represented.

The plants in the following list which I have not seen, I give on the authority of Prof. F. H. Snow, of the Kansas State University, and Prof. E. Hall, of Athens, Illinois, who has made more than one journey through Kansas to observe its botany. And I would especially commend to the notice of those who have not seen it, a paper of his in the Report of the Department of Agriculture for 1870, on the grasses of the region between the Mississippi and the Rocky Mountains. It will interest the farmer as well as the botanist. For the list of ferns I am indebted to Mr. James Wilson, of Leavenworth. A few plants have been sent me by Prof. Mudge, of the Agricultural College. No doubt in the western part of Kansas, differing geologically from the eastern, and especially in the salt and gypsum regions, some peculiar plants will be found.

J. H. CARRUTH.

Plants not in Wood's Class Book nor Gray's Manual are marked thus, *. Those that are introduced or came themselves are marked thus, †.

CATALOGUE OF THE PLANTS OF KANSAS.

RANUNCULACEAE.

Clematis, Virgin's Bower.

C. verticillaris. Mrs. Craig of Franklin county. Rare.

C. Virginiana. Rare.

C. Viorna. Leather flower. Among bushes; not common.

Anemone, Windflower.

A. Caroliniana.

A. Virginiana.

A. Pennsylvanica.

A. cyliudrica.

Thalictrum, Meadow Rue.

T. Cornuti.

Ranunculus, Crowfoot.

R. multifidus.

R. oblongifolius.

R. abortivus.

R. repens. Snow.

Myosurus, Mousetail.

M. minimus. Rare.

Isopyrum, False Rue Anemone.

I. biternatum. Snow.

Aquilegia, Columbine.

A. Canadensis. Cliffs near Humboldt.

Delphinium, Larkspur.

D. tricorne. Wet grounds; common; flowers deep violet.

D. azureum, variety virescens. Flowers greenish white; common on prairies.

†D. Consolida. Snow.

ANONACEAE.

Asimina, Pawpaw.

A. triloba. Woods near streams.

MENISPERMACEAE.

Menispermum, Moonseed.

M. Canadense. Climbs bushes.

BERBERIDACEAE.

Podophyllum, May Apple, Mandrake.

P. peltatum. Common.

NYMPHÆACEAE.

Nelumbium, Water Bean.

N. luteum. Yonkopin (an Indian name). Ponds near streams, splendid.

PAPAVERACEAE.

Argemone, Prickly Poppy.

†A. Mexicana. Snow.

FUMARIACEAE.

Dicentra, Ear-drop.

D. cucullaria. Snow.

Corydalis, Corydalis.

C. aurea. Golden corydalis. Lawrence.

CRUCIFERAE.

Nasturtium, Water Cress.

N. tanacetifolium.

N. sinuatum.

N. palustre.

Iodanthus, False Rocket.

I. hesperidioides. Snow.

Arabis, Rock Cress.

A. dentata. Snow.

Sisymbrium.

S. officinale. Hedge mustard.

S. canescens. Tansy mustard. Snow.

Draba, Whitlow Grass.

D. cuneifolia. Snow.

Sinapis, Mustard.

S. nigra. Black Mustard.

Capsella, Shepherd's Purse.

†C. bursa-pastoris. Common.

Lepidium, Pepper Grass.

L. Virginicum.

L. ruderale. Common.

CAPPARIDACEAE.

Cleome, Spider Flower.

*C.——. Undetermined; sent from western Kansas by Professor Mudge. Pretty, but ill-scented.

Polanisia.

P. graveolens. Quarries, Lawrence.

VIOLACEÆ.

Viola, Violet.

V. delphinifolia. Common.

V. cucullata. Common.

V. pubescens.

HYPERICACEAE.

Hypericum, St. John's-wort.

H. corymbosum. Rare.

H. angulosum. Snow.

CARYCPHYLLACEAE.

Silene, Campion, Catchfly.

S. stellata. Common.

S. antirrhina. Snapdragon catchfly.

Cerastium, Mouse-ear Chickweed.

C. viscosum. Snow.

Mollugo, Carpet Weed.

†M. verticillaris. A common weed.

PORTULACACEAE.

Portulaca, Purslane.

†P. oleracea. Too common.

Talinum.

*T. parviflorum. Snow.

Claytonia, Spring Beauty.

C. Virginica (?) (Possibly C. Caroliniana).

MALVACEÆ.

Malva, Mallows.

†M. rotundifolia.

Sida.

S. spinosa. Becoming troublesome in gardens.

Abutilon, Indian Mallows.

†A. Avicennæ. Roadsides. Said to be troublesome in Illinois.

Hibiscus.

H. Trionum. Flower-of-an-hour. Escaped from gardens.

H. militaris. Wet places. Resembles hollyhock.

TILIACEÆ.

Tilia, Linden.

T. Americana. Basswood. Not common.

LINACEÆ.

Linum, Flax.

L. sulcatum. Prairies. Scattered.

GERANIACEÆ.

Oxalis, Wood Sorrel.

O. violacea. Common.

O. stricta. Common.

Geranium, Crane's-bill.

G. Carolinianum.

Impatiens, Touch-me-not.

I. pallida.

RUTACEÆ.

Xanthoxylum, Prickly Ash.

X. Americanum.

ANACARDIACEÆ.

Rhus, Sumac.

R. glabra. Common.

R. copallina. Mountain Sumac.

R. Toxicodendron. Poison Ivy.

R. radicans. Climbing Ivy.

R. aromatica. Sweet Sumac.

SAPINDACEAE.

Acer, Maple.

A. dasycarpum. White maple. River banks.

A. saccharinum. Sugar maple. Linn county.

Negundo, Box Elder.

N. aceroides. Common.

Staphylea, Bladdernut.

S. trifolia. Occasional.

Æsculus, Buckeye.

Æ. glabra?

CELASTRACEAE.

Celastrus, Staff Tree.

C. scandens. Common.

Euonymus, Burning Bush.

E. atropurpureus.

RHAMNACEAE.

Ceanothus, Jersey Tea.

C. Americanus. Prairies.

C. ovalis.

Rhamnus, Buckthorn.

R. lanceolatus. Near streams.

VITACEAE.

V. æstivalis? Common. Leaves not rust-colored beneath; panicles loose, fruit tart, ripe in October.

V. cordifolia. Leaves dark green; panicle loose, fruit very small, tart, ripe in September.

V. riparia. Leaves light green; panicle compact, fruit pleasant, ripe July to September.

V. vulpina? One place. Leaves small, shining on both sides, most below, slightly lobed, teeth crenate, slightly mucronate.

V. indivisa. Fruit not eatable.

V. quinquefolia. Virginia creeper, common.

POLYGALACEAE.

Polygala, Milkwort.

P. incarnata. Prairies, scattered.

P. verticillata. Lawrence.

LEGUMINOSAE.

Schrankia, Sensitive Brier.

S. uncinata. Common.

Desmanthus.

D. brachylobus. Has a cluster of hooked pods.

Gymnocladus, Coffee Tree.

G. Canadensis. Frequent.

Gleditschia, Honey Locust.

G. triacanthos. Common.

Cassia, Senna.

C. chamæcrista. Sensitive pea. Common.

C. Marylandica. American senna. Occasional.

Cercis, Redbud.

C. Canadensis. Common.

Baptisia, Wild Indigo.

B. leucophæa. Common.

B. leucantha. Common.

B. australis. Snow.

Vicia, Vetch.

V. tetrasperma. Lawrence.

V. Americana.

V. Caroliniana. Snow.

Desmodium, Bush Trefoil.

D. nudiflorum.

D. acuminatum.

D. viridiflorum.

D. cuspidatum.

D. Canadense.

D. sessilifolium.

D. ciliare.

D. canescens.

D. paniculatum.

Lespedeza, Bush Clover.
L. capitata. Prairies; common.
L. violacea.
L. repens.

Crotalaria, Rattle Pod.
C. sagittalis.

Trifolium, Clover.
†T. repens. White clover.
†T. pratense. Red clover.
T. reflexum. Buffalo clover. Rare.
T. ———. One plant on bank of Wakarusa. At the time I made it T. carolinianum, but ? Flowers flesh-colored.

Melilotus.
†M. alba. Sweet clover. Gardens.

Psoralea.
P. floribunda. Prairies; common.
*P. argophylla. Prairies; scattered.
P. stipulata. Prairies; rare.
*P. esculenta. Prairies; not common. Has a root shaped like a turnip, one inch in diameter; eaten by Indians.

Amorpha, Lead Plaut.
A. fruticosa. Prairies; common.
A. canescens. Prairies; common.

Dalea.
D. alopecuroides. Prairies; common.

Petalostemon.
P. candidum. Prairies; common.
P. violaceum. Prairies; common.

Astragalus, Milk Vetch.
A. Canadensis. Occasional.
A. caryocarpus. Prairie pea. Rocky places; common.
A. Mexicanus. Snow.

Tephrosia, Goat's Rue.
T. Virginica. Handsome. Indicates sand in the soil.

Robinia, Locust.
†R. pseudacacia. Yellow locust. Likes the country, but not the borers.

Apios, Ground Nut.
A. tuberosa. Wet places; tubers, several on a root; eatable when cooked.

Phaseolus, Kidney Bean.
P. diversifolius. Sandy places.
P. pauciflorus. Not common.

Amphicarpea, Pea Vine.
A. monoica. Bushes.
A Pitcheri ?

ROSACEAE.

Prnnus, Plum and Cherry.
P. Americana. Wild Plum. Common.
P. serotina. Black Cherry. Rare.

Rubus, Bramble.
R. villosus. High blackberry. Bushes, common.
R. Canadensis. Northern dewberry. Stony places; occasional.
R. occidentalis. Black raspberry. Bushes; common.

Geum, Avens.
G. album. Not rare.
G. Virginianum. Not rare.
G. ———? Root leaves polywoggy.

Fragaria, Strawberry.
F. Virginiana. Polygamous; the pistillate blossoms have small petals; common.

Potentilla, Cinquefoil.
P. Canadensis. Five-finger.
P. Norvegica.
P. paradoxa. Snow.

Rosa, Rose.
R. setigera. Prairie Rose. Bushes, fine, cultivated.
R. lucida. Prairies.
R. blanda. More common than the last. A variety of one of these has fruit conical, eight or ten together.

Agrimonia, Agrimony.
A. eupatoria.
A. parviflora.

Cratægus, Thorn.
C. tomentosa. Blackthorn. Common.
C. crus-galli. Cockspur thorn. Miami county.

Pyrus, Apple, Pear, etc.
P. coronaria. Wild Crab. Common.

SAXIFRAGACEAE.

Ribes, Currant, Gooseberry.
R. lacustre. Gooseberry, with prickly stems and bristly fruit; wet ground.
R. rotundifolium. A smooth gooseberry. woods; common.

CRASSULACEAE.

Sedum, Stone Crop.
S. pulchellum. Snow.

Penthorum, Virginia Stone Crop.
P. sedoides. Wet places.

LYTHRACEAE.

Lythrum, Loosestrife.
L. alatum. Damp; common.

Ammannia.
A. latifolia. Wet.

ONAGRACEAE.

Jussiæa.
J. repens. River mud.

Œnothera, Evening Primrose.
Œ. sinuata. Snow.
Œ. biennis. Common.
Œ. pumila.
Œ. linearis. Near Black Jack.
Œ. Missouriensis. Common; flower very large; fruit large, four-winged.
Œ. speciosa. Common; flowers change from white to red.

Gaura.
G. biennis. Common.
*G. linifolia. Common; pretty.
*G. mollis.

Ludwigia, Bastard Loosestrife.
L. alata. Wet.

Circæa, Enchanter's Nightshade.
C. lutetiana.

LOASACEAE.

Mentzelia.
M. oligosperma. Limestone quarries; leaves adhere to clothing.
*M. ornata. Flowers large and handsome, sent from western Kansas by Prof. Mudge.

CUCURBITACEAE.

Echinocystis, Balsam Apple.
E. lobata. Climbing, fruit prickly.

Sicyos, Single-seeded Cucumber.
S. angulata.

Cucumis, Cucumber.
*C. perennis. Gardens; tap root one inch in diameter twenty inches down; probably a native of the west.

CACTACEAE.

Opuntia, Prickly Pear.
O. vulgaris. Miami county.
O. Missouriensis. Hall.

Mamillaria.
M. vivipara. Hall.

UMBELLIFERAE.

Sanicula, Sanicle.
S. Canadensis. Wakarusa flats.

Eryngium.
E. yuccæfolium. Prairies; common; leaves broad-linear, parallel-veined.
E. Leavenworthii. Hall.

Polytænia.
P. Nuttallii. Hall.

Peucedanum, Dill, Parsnip.
*P. fœniculaceum. Stony places; common.
†P. sativum. Parsnip.

Osmorrhiza.
O. longistylis. Sweet Cicely. Miami county.
O. brevistylis. Near Clinton.

Chærophyllum, Chervil.
C. Tainturieri. Snow.

Carum, Caraway, etc.
C. aureum. Golden Alexanders.

Pimpinella, Anise, etc.
P. integrifolia. Seen once.

Apium, Celery, etc.
A. lineare. Wet.

CORNACEAE.

Cornus, Dogwood.
C. sericea. Common.
C. paniculata.

CAPRIFOLIACEAE.

Triosteum, Feverwort.
T. perfoliatum. Occasional.

Symphoricarpos, Snowberry.
S. vulgare. Frequent.

Sambucus, Elder.
S. Canadensis. Common.

Viburnum, Snowball, etc.
V. prunifolium. Black Haw.
V. Lentago. Sweet Viburnum. Snow.

RUBIACEAE.

Galium, Cleavers.
G. triflorum. Snow.
G. trifidum. Snow.
G. concinnum. Snow.
G. Aparine.

Houstonia, Bluets.
H. cærulea. Snow.
H. minima. Snow.
H. tenuifolia. Variety of H. longifolia.

Cephalanthus, Buttonbush.
C. occidentalis. Common.

COMPOSITÆ.

Vernonia, Ironweed.
V. fasciculata. Wet lands; glabrous.
V. ovalifolia. Common.
*V. Arkansana. Hall.

Liatris, Button Snakeroot, etc.
L. squarrosa. Blazing Star.
L. Boykinii. In sandy places.
L. scariosa. Gay Feather. Common.
L. pycnostachya.

Kuhnia.
K. eupatorioides. Common.

Eupatorium, Boneset.
E. purpureum.
E. altissimum.
E. perfoliatum. Boneset. Near Black Jack.
E. ageratoides.

Aster, Aster.
A. cordifolius.
A. Novæ-Angliæ.
A. Novi-Belgii.
A. Tradescanti. Snow.
A. multiflorus. Hall.
A. lævis.
A. oblongifolius.
A. azureus. Hall.
A. sericeus.
A. tenuifolius.
A. carneus.
A. ericoides. (Probably more.)

Erigeron, Fleabane.
E. Canadense. Hall.
E. divaricatum. Lawrence.
E. nudicaule. Lawrence.
E. bellidifolium. Common.
E. Philadelphicum. Common.
E. strigosum. Snow.

Boltonia.
B. glastifolia. Snow.

Solidago, Goldenrod.
S. squarrosa.

S. petiolaris.
S. puberula. Snow.
S. nemoralis. Common.
S. Missouriensis.
S. Canadensis.
S. stricta.
S. rigida. Common.
S. tenuifolia. Common.
*S. linifolia. Hall.

Chrysopsis.
C. villosa. Snow.

Eclipta.
E. alba. River mud.

Silphium, Rosinweed.
S. laciniatum. Polar plant; leaves north and south.
S. integrifolium.
S. perfoliatum. Cup plant; leaves make a cup; all common.

Parthenium.
P. integrifolium. Seen once.

Iva, Marsh Elder.
I. ciliata. Low, rich soil.

Ambrosia, Horseweed.
A. trifida. Rich soil.
A. artemisiæfolia. Hogweed. Roman Wormwood. Fields.
A. psilostachya. Hall. Prairies.

Xanthium, Clotbur.
X. strumarium. Troublesome.

Echinacea, Purple Coneflower.
E. purpurea ? Prairies.
E. angustifolia. Prairies.

Helicpsis, Ox-eye.
H. scabra. Variety of H. lævis; common.

Rudbeckia, Coneflower.
R. subtomentosa.
R. speciosa.

Lepachys.
L. pinnata. Lawrence.
*L. columnaris. Lawrence.

Helianthus, Sunflower.
H. rigidus.
H. giganteus.
*H. petiolaris. Common.
H. tomentosus.
H. grosse-serratus. Common.
H. mollis.
H. decapetalus.
H. doronicoides.
H. strumosus.
*H. orgyalis. South only.
*H. lenticularis. Hall.
*H. Maximiliani. Hall. And more.

Actinomeris.
A. squarrosa.

Coreopsis, Tickseed.
C. tinctoria. Hall.
C. delphinifolia.
C. palmata. Prairies.
C. aristosa. Scales linear, wavy; wet, [common.

Bidens, Bur Marigold.
B. frondosa. Beggar-ticks. Lawrence.
B. connata. Lawrence.
B. cernua. Lawrence.
B. chrysanthemoides.

Verbesina, Crown-beard.
V. Virginica. Wakarusa flats.

Grindelia.
*G. squarrosa *or* glutinosa. Lawrence.

Prionopsis.
*P. ciliata.

Dysodia, False Dog-fennel.
D. chrysanthemoides. Streets.

Helenium.
H. autumnale.
H. quadridentatum.

Anthemis, Chamomile, etc.
A. Cotula. Mayweed. Roads.

Amphyachyris, Tumbleweed.
*A. dracunculoides. South. Hall.

Achillea, Yarrow.
A. millefolium. Common.

Tanacetum, Tansy.
†T. vulgare.

Artemisia, Wormwood.
A. Ludoviciana. Common.
A. vulgaris.
A. Canadensis.
*A. dracunculoides.

Gnaphalium, Everlasting.
G. polycephalum. Snow.

Antennaria.
A. plantaginifolia. Common.
*A. dioica. Hall.

Erechtites, Fireweed.
E. hieracifolius.

Cacalia, Tassel-flower.
C. tuberosa. Common.
C. atriplicifolia. Common.
C. reniformis. Snow.

Senecio, Groundsel.
S. aureus.

Cirsium, Thistle.
C. altissimum. Frequent.

Lappa, Burdock.
†L. officinalis. Came in 1865.

Hieracium, Hawkweed.
H. longipilum.

Nabalus, Drop-flower.
N. racemosus. Scattered.
N. asper. Scattered.

Troximon.
T. cuspidatum.

Taraxacum.
†T. dens-leonis. Came in 1866.

Lactuca, Lettuce.
L. elongata. Common.

Sonchus, Sow Thistle.
S. asper.

LOBELIACEÆ.

Lobelia.

L. cardinalis. Cardinal flower. Miami county.
L. syphilitica. Common.
L. leptostachys.

CAMPANULACEÆ.

Campanula, Bell-flower.

C. Americana.

Specularia, Venus's Looking-glass.

S. perfoliata. Common.
S. Ludoviciana. Snow.

EBENACEÆ.

Diospyros, Persimmon.

D. Virginiana. South; common.

PRIMULACEÆ.

Androsace.

A. occidentalis. Snow.

Lysimachia, Loosestrife.

L. hybrida. Common.
L. ciliata. Common.

PLANTAGINACEÆ.

Plantago, Plantain.

†P. major.
P. aristata, Rare.
P. gnaphalioides. Snow.
P. Virginica. Rare.

LENTIBULARIACEÆ.

Utricularia, Bladderwort.

U. vulgaris. Near Clinton.

OROBANCHACEÆ.

Aphyllon, Naked Broomrape.

A. uniflora. Snow.

BIGNONIACEÆ.

Martynia, Unicorn Plant.

†M. proboscidea. Escaped from gardens.

SCROPHULARIACEÆ.

Verbascum, Mullein.

†V. Thapsus. Occasional.
†V. Blattaria. Once.

Scrophularia, Figwort.

S. nodosa.

Pentstemon, Beard-tongue.

P. digitalis.
*P. Cobœa. Rocks; common.
*P. tubiflorus. Snow.

Mimulus, Monkey-flower.

M. ringens. Snow.
M. alatus. Common.

Herpestis.

H. rotundifolia. Water; flowers white; curious.

Ilysanthes.

I. gratioloides. Snow.

Veronica, Speedwell.

V. Virginica.
V. peregrina. Snow.

Buchnera, Bluehearts.

B. Americana. Near Black Jack.

Seymeria.

S. macrophylla. Near Baldwin.

Gerardia.

G. auriculata.
G. tenuifolia.
G. asperifolia. Hall.

Pedicularis, Lousewort.

P. Canadense.

ACANTHACEAE.

Ruellia.

R. strepens.
R. ciliosa. Common.

Dianthera.

D. Americana. Near Clinton.

VERBENACEAE.

Verbena, Vervain.

V. angustifolia.
V. hastata. Streets; common.
V. urticæfolia. Streets; common.
V. stricta. Streets; common.
V. bracteosa.
V. Aubletia. Rocks; common.

Lippia, Fog-fruit.

L. nodiflora.

Phryma, Lopseed.

Ph. leptostachya.

LABIATAE.

Teucrium, Germander.

T. Canadense. Common.

Isanthus, False Pennyroyal.

I. cæruleus.

Mentha, Mint.

M. arvensis.
M. Canadensis.

Lycopus, Water Horehound.

L. Europæus. Common.

Hedeoma, American Pennyroyal.

H. hispida. Lawrence.

Pycnanthemum, Basil.

P. lanceolatum.
P. linifolium.
P. pilosum.

Salvia, Sage.

*S. Pitcheri. Prairies; common.
*S. trichostemmoides. Roads.

Monarda, Mountain Mint.

M. fistulosa (whistulosa?). Common.

Blephilia.

B. hirsuta. Near Baldwin.
B. ciliata. Near Baldwin.

Lophanthus, Hedge Hyssop.

L. nepetoides. Near Baldwin.

Nepeta, Catmint.
†N. cataria.
†N. glechoma. Snow.

Brunella, Self-heal.
B. vulgaris. Common.

Scutellaria, Skullcap.
S. parvula.

Physostegia, Lion-heart.
P. Virginiana. Wet, pretty.

Stachys, Hedge Nettle.
S. glabra.

Leonurus, Motherwort.
†L. cardiacus.

Marrubium, Horehound.
†M. vulgare.

BORAGINACEÆ.

Onosmodium.
O. Virginianum. Common.
O. Carolinianum. Near Clinton.
O. molle. Snow.

Lithospermum, Gromwell.
L. angustifolium.
L. canescens. Puccoon. Common.
L. longiflorum. South of Baldwin.
L. hirtum. Snow.

Cynoglossum, Hound's Tongue.
†C. officinale.
C. Morrisoni. Beggar-ticks.

HYDROPHYLLACEÆ.

Hydrophyllum, Waterleaf.
H. Virginicum.

Ellisia.
E. Nyctelea. Along streams.

POLEMONIACEÆ.

Phlox, Lychnidea.
P. pilosa. Prairies. Common.
P. divaricata, variety Laphami. Woods

CONVOLVULACEÆ.

Pharbitis, Morning Glory.
†P. purpurea. Purple.
†P. Nil. Blue. Both tenacious as weeds.

Ipomœa.
I. lacunosa.
I. pandurata. Wild potato.

Calystegia.
C. spithamæa. Snow.
C. Sepium. Rutland Beauty. Troublesome.

Cuscuta, Dodder.
C. glomerata. Common.
C. compacta, variety appressa. Snow.
C. chlorocarpa. Lawrence.
C. decora. Snow.

SOLANACEÆ.

Solanum, Potato, etc.
S. nigrum. Nightshade. Gardens.
S. carolinense. Horse Nettle. Fields.
*†S. rostratum. Waste grounds. Came in 1864.

Physalis, Ground Cherry.
I have had six forms (species?) not including P. Philadelphica, which I know, growing in my garden the past year, all but the first spontaneous. Of the first two I have often seen the seed-leaves; the last four I have traced to old roots. None of them have "anthers purple," but the four that have "corolla spotted" have the fleshy filaments violet or purple. All but the P. lanceolata grow as they please, not regarding the descriptions in the books. I guess at four. The last seems not in the books. I give only some points, not full descriptions.

P. viscosa (?) Annual; not viscid; brownish green; pedicels half inch; corolla four lines broad; fruit calyx roundish, five-angled; fruit eatable.

P. nyctaginea (?) Annual; clammy; odorous, strong as the tomato; light green; leaves one to two inches long; pedicels half inch; corolla not spotted, three lines broad: fruit calyx roundish, ten-angled.

P. Pennsylvanica (?) Perennial; glabrous, erect, two feet high, branching above, simulating a walnut tree; leaves single; pedicels one inch; corolla spotted, eight or ten lines; fruit calyx truncate at base, cylindric-conic, or with ten or twenty angles.

P. lanceolata. Perennial, eight inches high, decumbent, bush-like; leaves in pairs; corolla spotted, ten lines; fruit calyx like a junk-bottle.

P. pubescens (?) Perennial; low, broad, very pubescent; pedicels long, oval, pointed.

*P. ———. Perennial; low, bushy, decumbent; leaves rhombic-oval, entire; pedicels nearly two inches: corolla not spotted; fruit calyx large, oval, five-angled.

Datura, Thorn-apple, Jimson-weed.
D. Stramonium. Waste ground.

GENTIANACEÆ.

Gentiana, Gentian.
G. alba.
G. puberula. Snow.
G. Saponaria.
G. Andrewsii. Snow.

APOCYNACEÆ.

Apocynum, Dogbane.
A. cannabinum. Common.

ASCLEPIADACEÆ.

Asclepias, Milkweed.
A. Cornuti.
A. purpurascens.
A. obtusifolia.
A. incarnata.
A. tuberosa. Common.
A. verticillata.
A. Meadii. Snow.
*A. obovata (?)

Acerates.
A. viridiflora.
A. longifolia.
A. monocephala. Snow.
A. paniculata. Common.
*A. angustifolia.

OLEACEÆ.

Fraxinus, Ash.

F. Americana. White Ash. Rare.
F. viridis. Green Ash. Common.

ARISTOLOCHIACEÆ.

Asarum, Wild Ginger.

A. Canadense.

NYCTAGINACEÆ.

Oxybaphus.

O. nyctagineus.
O. angustifolius.
O. linearis.
O. albidus. Snow.

POLYGONACEÆ.

Rumex, Dock.

R. crispus. Yellow Dock.
R. altissimus. Peach-leafed Dock.
†R. acetosella. Snow.

Polygonum, Knotgrass, etc.

†P. aviculare.
†P. erectum. Said to be a variety of the preceding. Growing together they appear distinct and not graduating into each other.
P. tenue.
P. ramosissimum.
P. hydropiperoides. Mild Water-pepper.
P. acre. Smartweed.
P. hydropiper. Water Pepper.
P. Persicaria. Lady's Thumb.
P. Pennsylvanicum.
P. incarnatum.
P. amphibium.
P. Virginianum.
P. Convolvulus. Knot Bindweed. Fields.
P. dumetorum. Hedge Bindweed. Climbs bushes ten feet.

PHYTOLACCACEÆ.

Phytolacca, Poke.

P. decandra.

CHENOPODIACEÆ.

Chenopodium, Pigweed, etc.

C. album. Common Pigweed.
C. hybridum.
C. ambrosioides.

Cycloloma.

C. platyphyllum. River banks.

AMARANTACEÆ.

Amarantus, Amaranth.

A. paniculatus.
A. sanguineus. Blood-red variety of the preceding.
A. retroflexus.
A. hybridus.
A. chlorostachys.
A. albus. All garden weeds.

Amblogyne.

*A. Torreyi. A diœcious garden weed. I had one seven feet high and eleven feet in diameter.

SANTALACEÆ.

Comandra, Bastard Toad-flax.

C. umbellata. Snow.

EUPHORBIACEÆ.

Euphorbia.

E. marginata. Handsome.
E. corollata. Prairies. Common.
E. Curtisii.
E. heterophylla.
E. dentata.
E. hypericifolia.
E. humistrata.
E. cordifolia.
E. maculata.
E. serpens.
*E. hexagona.

Tragia.

T. urticæfolia. Lawrence.

Acalypha, Three-seeded Mercury.

A. Virginica. Lawrence.

Croton.

C. monanthogynus.
C. capitatus. Roads.

URTICACEAE.

Ulmus, Elm.

U. Americana. White Elm. Common.
U. fulva. Slippery Elm. Common.

Celtis, Hackberry.

C. occidentalis. Common.

Maclura, Osage Orange.

†M. aurantiaca. Hedges.

Morus, Mulberry.

M. rubra.

Urtica, Nettle.

U. dioica (?)
U. urens.

Laportea, Wood Nettle.

L. Canadensis.

Pilea, Richweed.

P. pumila.

Humulus, Hop.

H. lupulus. Occasional.

Cannabis, Hemp.

†C. sativa. Escaped.

PLATANACEAE.

Platanus, Buttonwood.

P. occidentalis.

JUGLANDACEAE.

Juglans, Walnut.

J. nigra. Black Walnut.

Carya, Hickory.

C. olivæformis. Pecan. Common south.
C. amara. Bitternut. Hall.
C. alba. Shagbark. Common.
C. sulcata. Shellbark. Bottoms.
C. porcina. Pignut. Common.

CUPULIFERAE.

Quercus, Oak.

Q. imbricaria. Shingle Oak. Clinton.
Q. laurifolia. Swamp Laurel Oak. Near Kansas City.
Q. nigra. Black Jack. Sandy land.
Q. rubra. Red Oak. Common.
Q. palustris. Pin Oak. Wet; south.

Q. tinctoria. Yellow bark Oak. Lawrence. Snow.
Q. coccinea. Scarlet Oak. Common.
Q. alba. White Oak. Near Baldwin.
Q. macrocarpa. Bur Oak. River bottoms.
Q. obtusiloba. Post Oak. Rocky land.
Q. prinus. Swamp Chestnut Oak. Common.
Q. bicolor. Swamp White Oak. Common.
Q. castanea. Chestnut Oak.
Q. prinoides. Dwarf Chestnut Oak.
*Q. lyrata (?) Acorn almost covered; near Tonganoxie.
*Q. ——— Shrub; leaves sessile, cordate, full, so as to fold in pressing; lobes sharply three angled.
*Q. ——— Leaves cruciform, lobes three angled, scales of cup with points.

Corylus, Hazel.
C. Americana. Common.

SALICACEÆ.

Salix, Willow.
S. tristis.
S. humilis. Snow.
S. discolor.
S. longifolia.
S. nigra.
S. cordata.
S. myricacea.
*S. ——— (?) Young branches densely tomentose, drab.

Populus, Poplar.
P. monilifera. Cottonwood. Streams.

CONIFERÆ.

Juniperus, Juniper.
J. Virginiana. Red Cedar. Rare.

ARACEÆ.

Arisæma, Indian Turnip.
A. triphyllum. Jack in the pulpit.
A. dracontium. Green dragon.

LEMNACEÆ.

Lemna, Duckmeat.
L. perpusilla.

TYPHACEÆ.

Typha, Cat-tail.
T. latifolia.

Sparganium, Bur Reed.
S. eurycarpum. Near Clinton.

NAIADACEÆ.

Potamogeton, Pondweed.
P. ——— Undetermined.

ALISMACEÆ.

Alisma, Water Plantain.
A. Plantago.

Sagittaria, Arrowhead.
S. variabilis. Common.

ORCHIDACEÆ.

Cypripedium, Lady's Slipper.
C. parviflorum. Snow.

Orchis, Orchis.
O. leucophea. White prairie O. Rare.

Spiranthes, Lady's Tresses.
S. gracilis. Miami county.
S. cernua. Near Clinton.

AMARYLLIDACEÆ.

Hypoxis, Stargrass.
H. erecta. Common.

IRIDACEÆ.

Iris, Flower-de-Luce.
I. versicolor. Snow.

Sisyrinchium, Blue-eyed Grass.
S. Bermudianum. Common.

*SMILACEÆ.

Smilax, Green-brier.
S. rotundifolia. Common.
S. peduncularis. Near Clinton.

LILIACEÆ.

Erythronium.
E. albidum. Prairies; very early.

Lilium, Lily.
L. Carolinianum. Rare.

Scilla, Squill.
S. esculenta. Quamash. Has a bulb at base of stem; common.

Allium, Onion.
A. mutabile. Wet; common.
A. striatum. Wet; more common.
A. Canadense. Snow.

Polygonatum, True Solomon's Seal.
P. biflorum.
P. giganteum. Snow.

Smilacina, Solomon's Seal.
S. stellata.

MELANTHACEAE.

Melanthium.
M. Virginicum. Wet; occasional.

PONTEDERIACEAE.

Heteranthera.
*H. callæfolia (?) It has ten to twelve blue flowers, about half of them inclosed in the spathe; near Eudora.
H. limosa. Same place.

COMMELYNACEAE.

Commelyna, Day-Flower.
C. Virginica. Curious; near Clinton.

Tradescantia, Spiderwort.
T. Virginica. Prairies; common.
T. pilosa. Snow.

CYPERACEAE.

Cyperus, Galingale.
C. filiculmis (?)
C. strigosus.

Eleocharis, Spiked Rush.
E. intermedia.

Scirpus, Bulrush.
S. divaricatus.
S. validus. Common Bulrush.
S. atrovirens.

Eriophorum, Cotton Grass.
E. ——— Not determined.

Carex, Sedge.
C. lenticularis.

GRAMINEAE, GRASSES.

Leersia, Cut Grass.
L. Virginica. Along rivulets, Lawrence.

Zizania, Wild Rice.
Z. aquatica, Twelve feet high; near Osawatomie.

Agrostis, Bent Grass.
A. scabra. Rough Hair Grass.

Sporobolus, Drop-seed Grass.
S. vaginæflorus. Hall says it is worthless, but about Lawrence, cattle feed it close, and it is about the only grass that stands feeding.
S. heterolepis. Hall. Hall says it is valuable and common south and west.
S. asper. Sand near Lawrence.
*S. cuspidatus. Hall.
*S. depauperatus. Hall.

Muhlenbergia, Dropseed Grass.
M. Mexicana.

Stipa, Feather Grass.
S. juncea. Weather Grass. Awns very long; base of seed bearded; ripe in June.

Paspalum.
P. setaceum. Curious; Lawrence. Hall says the only species west of the Mississippi.

Panicum, Panic Grass.
P. capillare. Common.
P. filiforme. Stools abundantly.
P. amarum.
P. virgatum. Common.
P. villosum. Pedicels flexuous.
P. dichotomum. Hall.
P. pauciflorum. Hall.

Oplismenus, Cockspur Grass.
O. crus-galli, variety muticus. Common.

Setaria, Bristly Fox-tail.
S. glauca. Bottle Grass. Everywhere.
S. viridis. Wild Timothy. Rare.

Cenchrus, Bur Grass.
C. tribuloides. Burs stick to clothes.

Phalaris, Canary Grass.
P. arundinacea.

Tricuspis.
T. seslerioides. False Red-top.

Kœleria.
K. cristata.

Diarrhena.
D. Americana. Bottoms; leaves broad; green in winter.

Eragrostis.
E. poæoides. Odorous; common.
E. pilosa.
E. tenuis. Pretty; panicle near two feet long.
E. capillaris. Hall.
E. pectinacea.

Poa, Spear Grass.
P. annua. Sent from the Arkansas by Professor Mudge.
†P. pratensis. Kentucky Blue Grass.

Uniola, Union Grass.
U. latifolia. Among the bushes; pretty.

Phragmites, Reed.
P. communis. Water; eleven feet high; near the Wakarusa.

Lepturus.
L. paniculatus. Looks like a branching wire.

Hordeum, Barley.
H. pusillum.

Elymus, Rye Grass.
E. Virginicus.
E. Canadensis.
E. Hystrix. Hedge-hog Grass; woods.

Leptochloa.
L. fascicularis.
Cynodon, Bermuda Grass, Crab Grass.
C. dactylon. Five fingers; a bad weed.

Spartina, Cord Grass.
S. cynosuroides. Wet; tall; tough; poor fodder; spikes one-sided.

Bouteloua.
B. curtipendula. Spikelets hang from the lower side.
B. obligostachya. Low; one-sided spikes at right angles; all on one side.

Tripsacum, Sesame Grass.
T. dactyloides. Tall; staminate flowers above the pistillate.

Andropogon.
A. furcatus. Forked stem; blue stem.
A. scoparius. Broom Grass.

Sorghum.
S. nutans. Wood Grass. Hall thinks the last three make eighty per cent. of the prairie grasses; they do not bloom every year.

EQUISETACEAE.

Equisetum, Horse-tail.

E. sylvaticum.
E. pratense. Snow.
E. hyemale. Scouring Rush. Snow.

FILICES, FERNS.

In the order given by Mr. Wilson. They were all found in Leavenworth county.

Adiantum, Maiden-hair.

A. pedatum Linn. Shady woods; abundant; this I have often seen.

Onoclea, Sensitive Fern.

O. sensibilis Linn. Shady thickets; common.

Woodsia, Rock Polypod.

W. obtusa Torrey. Calcareous rocks near Fort Leavenworth.

Cystopteris, Bladder Fern.

C. fragilis Bernh. Moist woods; abundant.

Aspidium, Shield Fern.

A. Goldianum Hook. Goldie's Fern. Shady woods; not frequent.

Asplenium, Spleenwort.

A. angustifolium Michx. Bank of Missouri; several places.

Botrychium, Rattlesnake Fern.

B. Virginicum Linn. Dry woods; hazel brush; common.

Allosorus, Rock Brake.

A. atropurpureus Gray. (Pteris, Linn.) Dry rocks; river bank; rare.

Camptosorus, Walking Fern.

C. rhizophyllus Link. Antigramma, J. Smith. Mossy rocks; river bank; rare.

Number of species, about 540.

Not east of the Mississippi, (?) 36.

Further observation may show some errors.

CATALOGUE OF THE BIRDS OF KANSAS.

BY PROF. FRANK H. SNOW, OF KANSAS UNIVERSITY.

The following list of birds is based upon the personal observations of the author during a residence of six years in Kansas. Valuable assistance has been rendered by a few friends of ornithology in Kansas, among whom special mention should be made of Edwin A. Popenoe, of Topeka, and Geo. F. Gaumer and Nelson J. Stephens, of Lawrence. Acknowledgments are also due to T. M. Brewer, M.D., of Boston, for important additions. The notes in quotation marks were furnished by him. The list already contains two hundred and eighty-two species, representing thirty-nine families, and is being constantly enlarged. The entire number of species will undoubtedly reach three hundred. In this catalogue, one hundred and twenty-seven birds known to breed in Kansas are marked with an asterisk (*).

This edition contains important additions by Prof. S. F. Baird, of the Smithsonian Institution, and Prof. J. A. Allen, of the Museum of Comparative Zoology, at Cambridge, whose names are appended to their respective contributions. The author is also indebted to these gentlemen for valuable notes upon some of the birds enumerated.

VULTURIDAE—VULTURES.

1.* Cathartes aura. Turkey Buzzard. Common, and comparatively tame, approaching quite near to farm houses and towns.

FALCONIDAE—HAWKS AND EAGLES.

2.* Falco anatum. Duck Hawk. Not common. Found breeding near Fort Hays, by J. A. Allen.

3. Hypotriorchis columbarius. Pigeon Hawk. Common.

4. Hypotriorchis Richardsonii. Richardson's Merlin. Baird.

5. Falco polyagrus. Prairie Falcon. Rare in winter.

6.* Tinnunculus sparverius. Sparrow Hawk. Very common.

7. Astur atricapillus. The Goshawk. Not common. A fine adult specimen in the collection of Dr. W. H. Saunders, of Lawrence.

8. Accipiter Cooperii. Cooper's Hawk. Not common.

9. Accipiter fuscus. Sharp-shinned Hawk. Occasional.

10. Buteo Swainsonii. Swainson's Hawk. Two undoubted specimens of this "far western" bird are in my collection. They were collected within five miles of Lawrence.

10a. Buteo insignatus. Brown Hawk. Now considered to be the same as the preceding.

11. Buteo Harlani. Black Warrior. A pair of these rare birds appeared within one mile of Lawrence, in October, 1871. The male, an adult, was captured by Nelson J. Stephens, in a plumage not seen before.

12.* Buteo borealis. Red tailed Hawk. Common in timber.

12a. Buteo montanus. Western Red-tail. A single specimen was taken in December, 1871, by William Osburn, of Lawrence. Generally considered to be the same species as the preceding.

13.* Buteo lineatus. Red-shouldered Hawk. Rare at Lawrence.
14. Buteo Pennsylvanicus. Broad-winged Hawk. Not common. Taken by E. U. Prentice of Topeka.
15. Archibuteo lagopus. Rough-legged Hawk. Abundant in winter.
16.* Nauclerus furcatus. Swallow-tailed Hawk. Rare. A pair taken in July, 1870, near Lawrence, by N. Deming.
17. Ictinia Mississippiensis. Mississippi Kite. Baird.
18.* Circus Hudsonius. Marsh Hawk. Abundant.
19. Aquila Canadensis. Golden Eagle. A fine specimen of this noble bird was captured alive seventeen miles from Lawrence, in January, 1869, and was kept in confinement by the writer for nearly two years. It is now in the collection of mounted specimens belonging to the University.
20.* Haliaetus leucocephalus. Bald Eagle. Not rare.
21. Pandion Carolinensis. Fish Hawk. Uncommon.

STRIGIDAE — OWLS.

22.* Strix pratincola. Barn Owl. Rare.
23.* Bubo Virginianus. Great Horned Owl. Not uncommon.
24.* Scops asio. Screech Owl. Abundant.
25. Otus Wilsonianus. Long-eared Owl. Quite common.
26. Brachyotus Cassinii. Short-eared owl. Common on the prairie in autumn and winter.
27. Syrnium nebulosum. Barred Owl. Common.
28. Nyctale Acadica. Saw-whet Owl. Rare.
29.* Athene hypogæa. Burrowing Owl. Abundant on the plains of Western Kansas.
30. Nyctea nivea. Snowy Owl. Rare in winter.

PSITTACIDAE — PARROTS.

31. Conurus Carolinensis. Parakeet, Carolina Parrot. Formerly abundant in the woods of Eastern Kansas; now seen occasionally in districts thinly settled.

CUCULIDAE — CUCKOOS.

32.* Coccygus Americanus. Yellow-billed Cuckoo. Quite common.
33.* Coccygus erythrophthalmus. Black-billed Cuckoo. Rare at Lawrence. Found breeding near Leavenworth, by Prof. John Wherrell, in 1872.

PICIDAE — WOODPECKERS.

34.* Picus villosus. Hairy Woodpecker. Common.
35.* Picus pubescens. Downy Woodpecker. Abundant.
36. Sphyrapicus varius. Yellow-bellied Woodpecker. "Taken in Kansas several times."
37.* Hylotomus pileatus. Black Wood Cock. Rare.
38.* Centurus Carolinus. Red-bellied Woodpecker. Abundant.
39.* Melanerpes erythrocephalus. Red-headed Woodpecker. Abundant. Not shunning man as in the Eastern States, but frequenting the cities and towns, as if domesticated.
40.* Colaptes auratus. Golden-winged Woodpecker. Often seen in the towns, but less bold than the last species.
40a. Colaptes hybridus. Hybrid Woodpecker. A mounted specimen is in the collection of Mr. O. S. George, of Topeka. Taken also at Lawrence in October, 1872.
41. Colaptes Mexicanus. Red-shafted Woodpecker. Taken in December, 1872, by Nelson J. Stephens, from a flock which remained for two or three weeks in the timber within two miles of Lawrence.

TROCHILIDAE — HUMMING BIRDS.

42.* Trochilus colubris. Ruby-throated Humming Bird. Common.

CYPSELIDAE — SWIFTS.

43.* Chætura pelasgia. Chimney Swallow. Once rare; becoming common.

CAPRIMULGIDAE — GOAT-SUCKERS.

44.* Antrostomus vociferus. Whippoorwill. Rare.

45.* Antrostomus Nuttallii. Poorwill. Allen. At Topeka. Common at localities in Eastern and Middle Kansas.

46.* Chordeiles popetue. Night-hawk. Common.

47. Chordeiles Henryi. Western Night-hawk. Allen. Near Fort Hays.

ALCEDINIDAE — KINGFISHERS.

48.* Ceryle alcyon. Belted Kingfisher. Common.

COLEOPTERIDAE — FLYCATCHERS.

49. Milvulus forficatus. Scissor-tail. Baird. Taken at Fort Riley by Dr. Coues.

50.* Tyrannus Carolinensis. King-bird, Bee-bird. Common.

51.* Tyrannus verticalis. Arkansas Flycatcher. "Western Kansas." Abundant also in Eastern Kansas.

52.* Myiarchus crinitus. Great Crested Flycatcher. Common; often seen in the towns.

53.* Sayornis fuscus. Phœbe Bird. Nests under bridges; common.

54. Contopus borealis. Olive-sided Flycatcher. "Passes through as a migrant."

55. Contopus Richardsonii. Short-legged Pewee.

56. Contopus virens. Wood Pewee. Probably breeds in Kansas.

57. Empidonax Traillii. Traill's Flycatcher. Probably breeds in Kansas.

58. Empidonax pusillus. Little Flycatcher.

59. Empidonax minimus. Least Flycatcher. Probably breeds in Kansas.

60. Empidonax flaviventris. Yellow-bellied Flycatcher. "Passes through in migration."

61.* Empidonax Acadicus. Small Green-crested Flycatcher. Eastern Kansas. Allen.

TURDIDAE — THRUSHES.

62.* Turdus mustelinus. Wood Thrush. Common in the timber.

63. Turdus Pallasii. Hermit Thrush. Baird. One specimen taken at Topeka, by J. A. Allen.

64. Turdus fuscescens. Wilson's Thrush. "Passes through in migration."

65. Turdus Swainsoni. Olive-backed Thrush. "Passes through in migration."

66.* Turdus migratorius. American Robin. Once rare, but becoming more common every year. Remains through the winter.

67.* Sialia sialis. Bluebird. Common. Remains through the winter.

68. Regulus calendula. Ruby-crowned Wren. Spring and fall. Stragglers seen in the breeding season at Lawrence in 1871.

69. Regulus satrapa. Golden-crested Wren. "Passes through in migration."

SYLVICOLIDAE — WARBLERS.

70. Anthus Ludovicianus. Titlark. Usually quite common in spring, and sometimes in fall; frequents ploughed fields and prairies.

71.* Mniotilta varia. Black and White Creeper. Common.

72. Parula Americana. Blue Yellow-back. Allen. Near Leavenworth.

73.* Protonotaria citrea. Prothonotary Warbler. "Found breeding at Neosho Falls."

74.* Geothlypis trichas. Maryland Yellow-throat.

75. Geothlypis Philadelphica. Mourning Warbler. Allen. One specimen taken at Topeka.

76.* Oporornis formosus. Kentucky Warbler. Common.

77.* Icteria viridis. Yellow-breasted Chat. Common.

78.* Helminthophaga pinus. Blue-winged Yellow Warbler. Allen. Near Leavenworth. Common in Eastern Kansas.

79. Helminthophaga chrysoptera. Golden-winged Warbler. Baird.
80. Helminthophaga ruficapilla. Nashville Warbler. Allen. Near Leavenworth.
81. Helminthophaga celata. Orange-crowned Warbler. "Passes through in migration."
82. Helminthophaga peregrina. Tennessee Warbler. "Passes through in migration."
83.* Seiurus aurocapillus. Oven-bird; Golden-crowned Thrush. Common.
84. Seiurus noveboracensis. Small-billed Water Thrush. Baird.
85.* Seiurus Ludovicianus. Large-billed Water Thrush.
86. Dendrœca virens. Black-throated Green Warbler. Baird.
87. Dendrœca cærulescens. Black-throated Blue Warbler. Baird.
88. Dendrœca coronata. Yellow-rump Warbler. Common in spring.
89. Dendrœca Blackburniæ. Blackburnian Warbler. Allen. Near Leavenworth.
90. Dendrœca Pennsylvanica. Chestnut-sided Warbler. "Passes through in migration."
91.* Dendrœca cærulea. Blue Warbler. Allen. Near Leavenworth.
92.* Dendrœca æstiva. Yellow-poll Warbler. Common.
93. Dendrœca superciliosa. Yellow-throated Warbler. "Probably breeds in Kansas. Seen in June at Neosho Falls."
94.* Dendrœca discolor. Prairie Warbler. Allen. Common in Eastern Kansas.
95.* Myiodioctes mitratus. Hooded Warbler. Allen. Near Leavenworth.
96. Myiodioctes pusillus. Green Black-Cap Flycatcher. "Migratory."
97.* Setophaga ruticilla. Red-start. Common.
98.* Pyranga rubra. Scarlet Tanager. Common in the timber.
99.* Pyranga æstiva. Summer Red-bird. Baird.

HIRUNDINIDAE — SWALLOWS.

100.* Hirundo horreorum. Barn Swallow. Seen at Leavenworth by T. M. Brewer, M.D.
101.* Hirundo lunifrons. Cliff Swallow. Common.
102.* Hirundo bicolor. White-bellied Swallow. Not so common as in the Eastern States.
103.* Cotyle riparia. Bank Swallow. Common.
104.* Cotyle serripennis. Rough-winged Swallow. Common.
105.* Progne purpurea. Purple Martin. Common.

BOMBYCILLIDAE — WAXWINGS.

106.* Ampelis cedrorum. Cedar Bird. Rare. More frequent in 1872.

LANIIDAE — SHRIKES.

107. Collurio borealis. Butcher Bird. Common in winter.
108. Collurio Ludovicianus. Loggerhead Shrike. Three specimens taken in January and February, 1871. Breeds in the Southern States. Taken also in March, 1873.
109.* Collurio excubitoroides. White-rumped Shrike. Abundant.
110.* Vireo olivaceus. Red-eyed Flycatcher. Common.
111.* Vireo gilvus. Warbling Flycatcher. Reported breeding, by J. A. Allen.
112.* Vireo Bellii. Bell's Vireo. Quite common.
113.* Vireo noveboracensis. White-eyed Vireo. Baird. Taken at Lawrence in June, 1872.
114. Vireo solitarius. Blue-headed Vireo. Baird.
115.* Vireo flavifrons. Yellow-throated Flycatcher.

LIOTRICHIDAE — MOCKING BIRDS.

116.* Mimus polyglottus. Mocking Bird. Not uncommon.
117.* Mimus Carolinensis. Cat-Bird. Common. Breeding abundantly in Lawrence.
118.* Harporhynchus rufus. Brown Thrush. Common.
119.* Thryothorus Ludovicianus. Great Carolina Wren. Not uncommon, but very shy; almost impossible to find its nest.
120. Thryothorus Bewickii. Bewick's Wren. Probably breeds in Kansas.

121. Cistothorus palustris. Long-billed Marsh Wren. Probably breeds in Kansas.
122. Cistothorus stellaris. Short-billed Marsh Wren. Probably breeds in Kansas.
123.* Troglodytes aedon. House Wren. Common.
124. Troglodytes hyemalis. Winter Wren. Baird.

CERTHIIDAE — CREEPERS.

125.* Certhia Americana. American Creeper.
126.* Sitta Carolinensis. White-bellied Nuthatch.
127. Sitta Canadensis. Red-bellied Nuthatch.
128.* Polioptila cærulea. Blue-eyed Gnatcatcher. Not common.

PARIDAE — TITMICE.

129.* Lophophanes bicolor. Tufted Titmouse. Abundant; a true resident, remaining through the winter.
130.* Parus septentrionalis. Long-tailed Chickadee.
131.* Parus atricapillus. Black-cap Titmouse. Common resident.

ALAUDIDAE — LARKS.

132.* Eremophila cornuta. Skylark. Very abundant; remains through the winter, when it moves in flocks and is commonly called "Snow Bird."

FRINGILLIDAE — FINCHES AND SPARROWS.

133. Pinicola Canadensis. Pine Grosbeak. "Occurs in winter; taken by Sidney Smith, of Leavenworth."
134. Carpodacus purpureus. Purple Finch. "Migratory."
135.* Chrysomitris tristis. Yellow Bird. Resident; seen in large flocks in winter.
136. Chrysomitris pinus. Pine Finch. "Rare in winter."
137. Curvirostra Americana. Red Crossbill. "Rare in winter."
138. Curvirostra leucoptera. White-winged Crossbill. "Rare in winter."
139. Plectrophanes nivalis. Snow Bunting. In winter, usually in same flock with the Skylark and Lapland Longspur.
140. Plectrophanes lapponicus. Lapland Longspur. Common in flocks in winter.
141. Plectrophanes pictus. Smith's Bunting. Baird.
142.* Plectrophanes ornatus. Chestnut-collared Bunting. Allen. Near Fort Hays. Common in Middle and Western Kansas.
143. Plectrophanes melanomus. Black-shouldered Longspur. Baird.
144. Plectrophanes Macownii. Macown's Longspur. Allen. Near Fort Hays in winter.
145. Passerculus Savanna. Savannah Sparrow.
146. Passerculus alaudinus. Lark Sparrow.
147.* Poœcætes gramineus. Grass Finch. Common.
148.* Coturniculus passerinus. Yellow-winged Sparrow. Abundant. Taken by Dr. Cooper. Nest found by E. A. Popenoe, July 7th, 1872, with nine eggs.
149. Coturniculus Henslowi. Henslow's Bunting. Shot at Topeka, April 26th, 1872, by E. A. Popenoe; two or three specimens seen.
150.* Chondestes grammaca. Lark Finch. A prairie bird and very abundant.
151. Zonotrichia leucophrys. White-crowned Sparrow.
152. Zonotrichia querula. Harris's Finch. Often taken in the winter; probably resident. Abundant in May along the Missouri river.
153. Zonotrichia albicollis. White-throated Sparrow. Common.
154. Junco Oregonus. Oregon Snow-bird. Occasional in winter; a specimen shot at Topeka, March 29th, 1870, by E. A. Popenoe.
155. Junco hyemalis. Black Snow-bird. Abundant in winter.
156. Poospiza bilineata. Black-throated Sparrow. "Taken by Dr. Coues, in Western Kansas."
157. Spizella monticola. Tree Sparrow. Abundant.

158.* Spizella pusilla. Field Sparrow. Common.
159.* Spizella socialis. Chipping Sparrow. Less common than at the East.
160.* Spizella pallida. Clay-colored Bunting. Baird.
161.* Melospiza melodia. Song Sparrow. Common in the timber.
162. Melospiza Lincolnii. Lincoln's Finch. "Migratory in spring and fall."
163.* Melospiza palustris. Swamp Sparrow. Common.
164. Peucæa Cassinii. Cassin's Finch. Allen. Near Fort Hays.
165. Passerella iliaca. Fox-colored Sparrow. Common in migration.
166. Passarella schistacea. Slate-colored Sparrow. Rare; only one specimen taken.
167.* Calamospiza bicolor. Lark Bunting. "Common in Middle and Western Kansas." Also seen in Eastern Kansas by Dr. Hoy.
168.* Euspiza Americana. Black-throated Bunting. Abundant on the prairie.
169.* Guiraca Ludoviciana. Rose-breasted Grosbeak. Common in the timber.
170.* Guiraca melanocephala. Black-headed Grosbeak. Allen. Near Fort Hays.
171.* Cyanospiza amœna. Lazuli Finch. "Western Kansas."
172.* Cyanospiza cyanea. Indigo Bird. Very common.
173.* Cardinalis Virginianus. Red Bird. Abundant and a true resident, remaining in winter.
174.* Pipilo erythrophthalmus. Ground Robin, Chewink. Common and resident.

ICTERIDAE — BLACKBIRDS.

175.* Dolichonyx oryzivorus. Bobolink. Rare about Lawrence. Not uncommon in Osage county in 1872.
176.* Molothrus pecoris. Cow-bird. Abundant.
177.* Agelæus phœniceus. Red-winged Blackbird. Abundant.
178.* Xanthocephalus icterocephalus. Yellow-headed Blackbird. Abundant; generally in the same flock with the Cow-bird.
179.* Sturnella magna. Meadow Lark. Abundant.
180.* Sturnella neglecta. Western Lark. This species, though closely resembling the preceding, has an entirely different song, and presents certain well-marked and constant differences of plumage. Both species are abundant in Eastern Kansas.
181.* Icterus spurius. Orchard Oriole. Common.
182.* Icterus Baltimore. Baltimore Oriole. Not uncommon.
183. Icterus Bullockii. Bullock's Oriole. Quite frequent. Five specimens taken at Lawrence in May and June, 1871; none seen in 1872.
184. Scolecophagus ferrugineus. Rusty Blackbird. "Migratory in spring and fall."
185. Scolecophagus cyanocephalus. Brewer's Blackbird. Quite common even in Eastern Kansas.
186.* Quiscalus versicolor. Crow Blackbird. Abundant, and without fear of man, often nesting in the city of Lawrence.

CORVIDAE — CROWS.

187.* Corvus carnivorus. American Raven. "Common on the plains of Western Kansas."
188.* Corvus Americanus. Common Crow. Common, and tamer than in the Eastern States.
189.* Pica Hudsonica. Magpie. Seen in Shawnee county, in October, 1871, by C. E. Pond. Reported as breeding, by J. A. Allen.
190. Cyanura cristata. Blue Jay. Abundant, resident; has little fear of man, often nesting in Lawrence.

COLUMBIDAE—PIGEONS.

191. Ectopistes migratoria. Wild Pigeon. Not common.
192.* Zenædura Carolinensis. Carolina Dove. Abundant throughout the State.

PHASIANIDAE — PHEASANTS.

193.* Meleagris gallopavo. Wild Turkey. Becoming rare in the towns; not uncommon in the timber elsewhere.

TETRAONIDAE — GROUSE.

194.* Pediœcetes phasianellus. Sharp-tailed Grouse. Allen. Common about Fort Hays and in Middle and Western Kansas, generally near the streams.

195.* Cupidonia cupido. Prairie Chicken. Abundant. Sold in the markets for $1.50 to $3.00 per dozen; protected by game law from March first to August first.

196. Bonasa umbellus. Ruffed Grouse or Partridge. Extremely rare; taken by Charles Chadwick, Esq., of Lawrence. Probably breeds in Kansas.

PERDICIDAE — PARTRIDGES.

197.* Ortyx Virginianus. Bob White or Quail. Eastern to Middle Kansas. Abundant; sold in the market for $1.00 per dozen; protected by game law from March 1st to October 1st.

GRUIDAE — CRANES.

198. Grus Americanus. Whooping Crane. Rare in migration. A fine specimen was shot near Lawrence in November, 1871. The mounted skin is in the university museum.

199. Grus Canadensis. Sandhill Crane. Abundant during the migrations.

ARDEIDAE — HERONS.

200. Garzetta candidissima. Snowy Heron. An adult specimen was taken at Topeka by E. U. Prentice, July 25th, 1872.

201. Herodias egretta. White Heron. Not common. Taken at Lawrence, August 15th, 1872.

202. Ardea herodias. Great Blue Heron. Not common. A female in full plumage was taken at Lawrence in May, 1872.

203.* Ardetta exilis. Least Bittern.

204.* Botaurus lentiginosus. Bittern, Stake Driver. Quite common.

205.* Butorides virescens. Green Heron. Common.

206.* Nyctiardea Gardenii. Night Heron. Rare.

CHARADRIDAE — PLOVERS.

207. Charadrius Virginicus. Golden Plover. "Migratory in October."

208.* Ægialites vociferus. Killdeer. Abundant.

209.* Ægialites montanus. Mountain Plover. Allen. Common in Western Kansas.

210. Ægialites semipalmatus. Ring Plover. Common in spring and fall.

211. Ægialites meloda. Piping Plover. Baird.

212. Squatarola helvetica. Black-bellied Plover. Baird.

RECURVIROSTRIDAE — AVOCETS.

213. Recurvirostra Americana. American Avocet. Rare. Probably breeds in Kansas.

PHALAROPODIDAE — PHALAROPES.

214. Phalaropus Wilsonii. Wilson's Phalarope. "Migratory in spring and fall."

SCOLOPACIDAE — SNIPES.

215.* Philohela minor. American Woodcock. Rare.

216. Gallinago Wilsonii. English Snipe. Common.

217. Macrorhamphus griseus. Gray Snipe. Common.

218. Macrorhampus scolopaceus. Greater Longbeak. "Migratory in spring and fall."

219. Tringa canutus. Knot, Robin Snipe. Common.

220. Tringa Alpina, var. Americana. Red-backed Sandpiper. Allen. Near Leavenworth.

221. Tringa maculata. Jack Snipe. Common.

222. Actodromas Bairdii. Baird's Sandpiper. Baird.
223. Tringa Wilsonii. Least Sandpiper. Abundant.
224. Tringa Bonapartii. Bonaparte's Sandpiper. "Migratory in spring and fall."
225. Ereunetes petrificatus. Semipalmated Sandpiper. "Migratory."
226. Symphemia semipalmata. Willet. "Occasional in fall." A large flock was seen on the Kansas River, near Lawrence, April 25, 1872.
227. Gambetta melanoleuca. Tell-tale, Stone Snipe. Common.
228. Gambetta flavipes. Yellow-legs. Abundant.
229.* Rhyacophilus solitarius. Solitary Sandpiper. Rare.
230.* Tringodes macularius. Spotted Sandpiper. Rare.
231.* Actiturus Bartramius. Field Plover. Abundant on the open prairie in May.
232. Tringites rufescens. Buff-breasted Sandpiper. Occasional in fall.
233. Limosa fedoa. Marbled Godwit. Rare.
234. Limosa Hudsonica. Hudson Godwit. Baird.
235.* Numenius longirostris. Long-billed Curlew. Not uncommon. Found breeding on the Plains of Western Kansas, by J. A. Allen.
236. Numenius Hudsonicus. Hudsonian Curlew. Baird.
237.* Numenius borealis. Esquimaux Curlew. Allen. A single specimen seen in Wes ern Kansas. Mr. Allen reports it as breeding in Kansas.

RALLIDAE — RAILS AND COOTS.

238. Rallus elegans. King Rail. Rare.
239.* Rallus Virginianus. Virginia Rail.
240. Porzana Carolina. Common Rail.
241. Porzana Jamaicensis. Little Black Rail. Allen. A single specimen taken.
242.* Fulica Americana. Coot, Mud-hen. Abundant in spring and fall.
243. Gallinula galeata. Florida Gallinule. Baird.

ANATIDAE — SWANS, GEESE, DUCKS.

244. Cygnus Americanus. American Swan. Rare.
245. Cygnus buccinator. Trumpeter Swan. "Migratory; breeds in Iowa."
246. Anser hyperboreus. Snow Goose. Common in migration.
247. Anser Gambelii. Laughing Goose. Taken at Topeka, February, 1872, and a Lawrence, September, 1869.
248. Bernicla Canadensis. Canada Goose. Abundant in spring and fall, sometimes remaining all winter.
249. Bernicla Hutchinsii. Hutchins's Goose. Baird.
250. Bernicla brenta. Brant. Common.
251. Anas boschas. Mallard. Common.
252. Anas obscura. Black Duck. Not common.
253. Dafila acuta. Common. Sometimes remains in winter.
254.* Nettion Carolinensis. Green-winged Teal. Abundant.
255.* Querquedula discors. Blue-winged Teal. Abundant. This and the preceding reported as breeding, by J. A. Allen.
256. Spatula clypeata. Shoveler. Common.
257. Chaulelasmus streperus. Gadwall. Common.
258. Mareca Americana.
259.* Aix sponsa. Summer or Wood Duck. The young of this species are good shooting and fine eating in August and September. Nearly all the other species are abundant for about two months, both in spring and fall, and are very common in the market.
260. Fulix marila. Greater Black-head, Blue-bill, Scaup Duck. Common.
261. Fulix affinis. Little Black-head. Common.

262. Fulix collaris. Ring-necked Duck. Common.
263. Aythya Americana. Red-head. Abundant.
264. Aythya vallisneria. Canvas-back. Not common.
265. Bucephala Americana. Golden Eye, Whistle Wing. Rare.
266. Bucephala albeola. Butter Ball. Common.
267. Erismatura rubida. Ruddy Duck. Rare.
268. Mergus Americanus. Sheldrake, Fish Duck. Common.
269. Mergus serrator. Red-breasted Merganser. Baird.
270. Lophodytes cucullatus. Hooded Merganser. Common.

PELECANIDAE — PELICANS.

271. Pelecanus erythrorhynchus. American Pelican. Common during the migrations, especially in the fall. A specimen taken near Lawrence, October 20, 1871, measured eight feet and five and three-sixteenth inches from tip to tip of wings.

PHALACROCORACIDAE — CORMORANTS.

272. Graculus dilophus. Double-crested Cormorant. Rare in migration.
273. Graculus Mexicanus. Mexican Cormorant. Rare; a single specimen taken four miles south of Lawrence, April 2d, 1872, by Geo. D. Allen. This is the first specimen taken north of the Rio Grande.

LARIDAE — GULLS, TERNS.

274. Larus argentatus. The Herring Gull or Silvery Gull. A single specimen is in possession of E. U. Prentice, Esq., of Topeka, who has prepared a fine collection of mounted birds.
275. Chrœcocephalus Franklinii. Franklin's Rosy Gull. A beautiful mounted specimen is in Mr. Prentice's collection.
276. Sterna Wilsoni. Wilson's Tern. Rare in migration.
277. Sterna Forsteri. Forster's Tern. Migratory.
278. Sterna frenata. Least Tern. Rare.
279. Hydrochelidon plumbea. Short-tailed Tern. Migratory.

COLYMBIDAE — GREBES.

280. Colymbus torquatus. Loon. Migratory.
281. Podicipes cornutus. Horned Grebe.
282. Podilymbus podicipes. Carolina Grebe, Dabchick. Common. Probably breeds in Kansas.

LAWRENCE, KANSAS, April 7th, 1873.

COALS OF KANSAS.

BY WILLIAM H. SAUNDERS.

At the request of Secretary Parker, I have condensed in the following paper the results of some chemical investigations, which I have from time to time made, of the quality of our Kansas coals.

Up to this time, so far as I know, no true bituminous coal has been found west of the Missouri river, and probably none exists.

Many valuable beds of coal, some of which are many feet in thickness, occur throughout the western part of the country, but all belong to that class of coals called lignites. On a close examination of the most compact, homogeneous specimens, laminæ of a soft, black, pulverulent substance like charcoal, retaining its original organic structure can be found, which assign them to the class of lignites.

In Kansas all qualities are found, from the soft, brown, woody lignite, destitute of bituminous matter, and showing plainly the original vegetable structure, to that so highly bituminized and homogeneous in quality, as to approach very nearly a true bituminous coal.

The general distribution, good quality, and easy access of our coal beds render it highly probable that in years to come Kansas may be made commercially independent, by the possession of a cheap means of preparing for use the crude products of the vast and varied industries that her fertile soil and varied resources are capable of sustaining.

The eastern half of the State lies on the western border of the great interior coal basin of the continent, where the outcrop of the strata would bring the coal to the surface. Owing to the very slight disturbance of the strata in this part of the west, they lie nearly horizontal, having a slight dip to the northwest and north, thus insuring the distribution of coal over a large area, and greatly facilitating mining operations, for, when once a bed is reached, the miner can work in any direction with no prospect of having his progress impeded by a fault in the strata.

At numerous places throughout the eastern half of the State, thin beds of coal of the upper coal measures outcrop along the hillsides,

but the thickest and best beds yet discovered outcrop in the lower coal measures of the extreme southern part and below.

As the dip of the strata is so uniform, and thick beds are generally continuous over a large area, an estimate can readily be made of the approximate depth it will be necessary to go at any point to reach them. Upon such a basis work was commenced in the shaft at Leavenworth, and coal reached at about the depth anticipated, although not of as great thickness as was expected.

In the northern part of Bourbon county, and from thence in a line northeast and southwest, outcrops a fine stratum of coal about thirty inches thick, called the "Osage vein," but generally known throughout the State as Fort Scott coal. This appears in commerce under two names, black and red; names derived from the external appearance of the lumps, the real difference in quality, if any, being in favor of the black. It contains a large amount of bituminous matter that furnishes abundantly a gas of high illuminating power. The amount of ash and sulphur it yields is a little larger than some other coals yield, but this does not detract materially from its superiority over most of them for general use. The coke from it is firm, but does not possess the body of coke from the best eastern coals

Farther south, in the center of Cherokee county, outcrops another stratum of coal six feet thick, that also stretches northeast and southwest, and is of finer quality than the preceding. For the production of gas and heating purposes it is the best coal in the State, the only drawback being a tendency to run together into a solid coke in the furnace, which, however, by a little attention, can be readily prevented. It yields a much larger quantity of illuminating gas than the Fort Scott coal, of equal quality, gives a coke of more body and heating capacity, less ash, and but little more sulphur. The Lawrence and Kansas City gas companies, after a thorough trial, pronounce this the best coal for the manufacture of gas that they can obtain from Kansas or Missouri.

The Leavenworth mine furnishes a fine, compact coal of greater heating capacity than the Fort Scott, but not equal to the Cherokee. It is not as rich in bituminous matter as the Fort Scott, and contains a decidedly larger percentage of sulphur that causes it to "clinker" badly.

These three are the best and leading coals of the State. Besides these, only two other fields are worked to any extent; one, the Osage county field, stretching from Carbondale to Osage City; the other at Grayville, Franklin county. These are of about the same quality, from twenty-four to thirty inches in thickness, yield a small

amount of illuminating gas of fair quality, a moderate per cent. of sulphur, a large per cent. of ash, and coke of inferior quality. These two coals, however, in one respect are superior to the others. They do not give a heavy coating of soot to everything in contact with their smoke, but burn clean, a fact which will recommend them strongly for use in the kitchen where utensils are frequently handled.

With increased railroad facilities the demand of the greater portion of the State will, without doubt, be supplied from the fields already mentioned.

No good coal has yet been found in Western Kansas. A few years ago a heavy bed of brown coal or pure lignite was worked at Wilson's creek, on the K. P. Railway, that in time may become valuable in that region so scantly supplied with fuel. It is notable for containing less sulphur than any other coal which I have seen in Kansas.

For use in metallurgy all our coals contain too much sulphur, and will require coking.

In the following tables are given the results of the chemical analyses which I have made of coals from Kansas and other parts of the west:

	KANSAS COALS.					COLORADO COALS.						MISSOURI.
	Wilson's Creek, K. P. R. W.	Carbondale, Osage county.	Coal Creek, Douglas county.	Lawrence Mine, Franklin county.	Fort Scott.	Marshall's Vein.	Golden City.	Kiowa.	Bijou Creek. (Cannel.)	K. P. R. W.	K. P. R. W.	Camden.
Water	7.50	.....	11.53	11.00	15.90	8.08	10.00	7.70	13.00	11.00	13.00	.....
Combustible Gases, cubic feet per pound	2.33	3.00	2 29	2.35	3.04	0.30	1.79	4.01	1.81	1.64	1.40	3.50
Illuminating power	low	high	high	high	highest	very low	fair	none	fair	low	none	high
Amount of Tar	small	medium	small	medium	medium	small	small	small	small	large	small	small
Sulphur	1.63	3.70	3.69	3.45	4.10	1.95	2.60	2.46	2.21	1.50	0.89	3.59
Coke	68.75	69.03	62.50	59.89	66.15	75.60	58.86	48.44	55.54	52.00	52.34	53.91
Ash	9.50	12.31	5.25	9.20	12.05	3.00	4.46	10.28	5.50	6.18	17.50	12.00
Rate of combustion in open air	fast	slow	medium	slow	medium	slow	medium	slow	fast	medium	medium	medium
OR:												
Volatile Matter	31.25	30.97	37.59	40.11	33.35	24.40	41.14	51.56	44.46	48.00	47.66	46.09
Fixed Carbon	59.25	56.72	57.25	50.69	54.10	72.60	54.40	38.16	50.04	45.82	34.84	41.91
Ash	9.50	12.31	5.25	9.20	12 05	3.00	4.46	10.28	5.50	6.18	17.50	12.00
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

From this table it will be seen that a marked difference exists between the coals of Kansas and those to the west of us. Sulphur diminishes to so small an amount westward, that the coals can be used in the raw state for metallurgy. The amount of volatile matter increases, but this is chiefly hydrogen with little or no illuminating power. The fixed carbon and the ash diminish.

Of those that I have analyzed, and others that I have seen, none are, I think, equal for general use, to our Cherokee coal.

One given in the table, Marshall's vein, differs in a marked degree, from all others. Its output is on South Boulder creek, at the base of the mountains near Denver, embracing a series of eleven beds that vary from five to thirteen feet in thickness. In appearance like anthracite, having a bright lustre, homogeneity of structure, leaving no stain when handled, containing but a slight amount of volatile matter, one is tempted, at first sight, to pronounce it anthracite, but an occasional thin lamina of pulverulent, carbonaceous matter shows that its place is among the lignites. Not the least item of interest is the small per cent. of sulphur in its composition, an amount that will not interfere with its use in the raw state for the working of metals. For all purposes, except the production of gas, this coal is the best of which I have any knowledge in the west.

The coal from Bijou creek is chiefly cannel coal, but does not contain the amount of bituminous matter usually found in this variety, which, elsewhere, is the most valuable of all for the production of illuminating gas.

LIMESTONES AND COAL.

CHEMICAL ANALYSES BY WILLIAM H. SAUNDERS.

The following quantitative chemical analyses are of two varieties of limestones from Junction City, and two varieties of coals, found along the line of the Kansas Pacific railroad, in Colorado. Stone No. 1 is the quality ordinarily used. No. 2 is from a new quarry lately opened. A decided difference will be noticed between the samples. No. 2 is free from pores, and although it has a very considerable amount of magnesia in its composition, it is my opinion, based on its compactness, the large amount of silicates present, and its slow solubility in acids, that it will prove more durable than the quality ordinarily used. The color, a light drab, is very fine:

LIMESTONES.	No. 1.	No. 2.
Hygrometric moisture escaping at 212° F.	.55	.75
Carbonate of Lime	88.85	67.23
Carbonate of Magnesia	4.15	17.45
Sesqui-oxide of Iron and Alumina, mostly Iron	1.20	2.05
Insoluble Silica and Silicates	5.10	12.20
Loss	.15	.32
	100.00	100.00

COAL NO. 1.

Water, hygrometric	11.00
Illuminating Gas	per lb., 1.64 cub. ft.
Quality	poor
Tar	abundant
Sulphur	1.50
Coke	52.00
Ash	6.18
Rate of Combustion in open air	medium

or,

Volatile matter	48.00
Fixed Carbon	45.82
Ash	6.18
	100.00

COAL NO. 2.

Water, hygrometric	13.00
Uncondensed Gases	per lb., 1.40 cub. ft.
Illuminating quality	none
Tar	small amount
Sulphur	0.89
Coke	52.34
Ash	17.50
Rate of combustion in open air	medium

or,

Volatile matter	47.66
Fixed Carbon	34.84
Ash	17.50
	100.00

No. 1 is a cannel coal. No. 2 is a fair lignite, distinguished for containing a very small per cent. of sulphur.

RED SANDSTONE OF CENTRAL KANSAS.

BY B. F. MUDGE.

Next above the Permian a belt of red sandstone, corresponding in appearance and (in part) in position with the new red sandstone of the older geologists, crosses the State of Kansas from the State line in Washington county in a southwesterly direction to the Indian Territory, passing out of the State near its southwestern corner. Its extent within our State is about three hundred miles, and its width in a northwesterly line varies from thirty to fifty miles. The middle and lower portion of this deposit has usually been assigned to the Triassic, but as it contains scarcely any fossils, and those not in good preservation, its true position is still uncertain. Prof. Swallow found but a single fossil, and that a doubtful nucula.* Other geologists have succeeded no better in collecting or identifying the fossils of this division of the red sandstone of Kansas. The only evidence that any portion of this sandstone is older than the Cretaceous, is the fact that in northern Nebraska, under the red sandstone of the Cretaceous, is a deposit of sandstone in physical characteristics, identical with ours, in which the fossils are recognized by Meek as clearly Jurassic. As the Cretaceous is traced uninterruptedly from thence to Kansas, and no unconformability is anywhere seen, it is not improbable that a portion of our territory is covered with Triassic or Jurassic rocks. Until further discoveries are made the question must be considered an open one, whether either of these formations exist in Kansas, though my opinion is they do not.

While we were in doubt concerning the age of the lower portion of this red sandstone deposit, we are not left in doubt in relation to the true position of the higher strata. Although there is no difference in the higher and lower strata, and it is even difficult to trace a single bed and identify it over an extent of twenty miles, yet the fossils of the later or higher deposits are well preserved and unmistakably Cretaceous.

The most marked and important fossils are the leaves of dicotyledonous plants. These are usually in good state of preservation, the veins and veinlets being frequently as clearly visible in all their outlines, as they lie imprinted on stone, as those just taken from living trees. These represent about a dozen different genera, the

* Meek, in the last report on the geology of this State and the adjoining territories, does not mention any Triassic fossils as found in Kansas.

most common of which are Liquidambar, Populus, Salix, Fagus, Quercus, Platanus, Sassafras, Liriodendron, Magnolia, and, more rarely, the Cinnamomum. These are represented by about fifty species, all extinct. In addition we find some of extinct races, as the Creducria and Dombeiopsis.

These fossils are found at uncertain intervals of territory. In searching for them we have frequently examined every visible outcrop for fifteen or twenty miles without finding a specimen, then perhaps a single square mile would furnish several good localities.

Our cabinet is represented by specimens collected from twenty-five or thirty places, from Washington county to Fort Larned, near the Arkansas, a distance of one hundred and seventy-five miles. The fossil plants are usually obtained from thin layers or strata, extending in a horizontal position along a ravine or around a hill. They may occur at several places in the same vicinity, but usually without any connection. Thus in Clay county, near Riverdale, they were found at the bottom of a well, as low as the bed of the Republican, and on the top of an adjoining hill two hundred feet high, with numerous strata between, in which none could be seen.

These deposits appear to have been local, dependent upon circumstances. There must have been, necessarily, an arm of the sea or lake, with soft, sandy mud, bordered by an adjoining dry land covered with a forest. The characteristic of the local deposits indicate that the forests were on small islands sparsely scattered over the Cretaceous ocean.

While plants are thus widely scattered in this sandstone, other fossils are extremely rare. In the vicinity of Fort Harker a few fish vertebræ and sharks' teeth are found. Though we have carefully searched over a large portion of the country covered by this deposit, both in the Cretaceous and the beds called Triassic, for mollusks and the common marine fossils, we have discovered them in but one locality, and that of very limited area.*

Three years ago, passing from Salina to Harker, when near what is now the town of Bavaria, we picked up in the road some marine fossils. Tracing the specimens to the top of an adjoining hill, we found a few acres covered with a stratum not over two feet in thickness, rich in small shells. We sent a box to Prof. Meek, of the Smithsonian Institution, for critical examination, who found twelve species new to science, a full description of which can be seen in Hayden's recent report of the United States Geological Survey of Wyoming and contiguous Territories, pages 297–313.

* Since the reading of this article before the Society, another locality has been found about four miles from Bavaria. They are in good preservation, differing very much from the first locality, but have not yet been critically examined.

The following is the list, which we believe includes nearly all the mollusks thus far found in the red randstone within the bounds of Kansas:

Crassatellina oblonga.
Area (?) parallela.
Yoldia microdonta.
Cardium Kansensis.
Cardium (Protocardia) Salinense.
Cyrena (Corbicula?) nucalis.
Cyrena(Corbicula?)subtrigonalis.
Tellina subscitula.
Tellina (?) mactroides.
Leptosolen Conradi.
Turritella Kansensis.
Turbo Mudgeanus.

These shells are in the same strata and in the vicinity of several deposits of the dicotyledonous leaves, and with the plants identify this portion of the sandstone as belonging to the Dakota group of the Cretaceous, as described by Meek and Hayden in their first report.

The sandstone varies in a great degree in various localities, and even in the same quarry. In color it varies from white to nearly black, but usually of a dark brown. Much of it makes an excellent building material, being durable and easily wrought.

Within the past four years the leaves have been found lower down, or nearer the Permian than they were previously known to exist. Those at the bottom of the well in Clay county must have been less than two hundred feet from the Permian.

The line of demarkation between the different geological formations of Kansas are very obscure. A physical unconformability I have never seen, and the division, as shown by a difference of fossils, the best criterion, is also very indistinct. We must consider, also, that the sandstones called Triassic and the Cretaceous in Kansas are so similar in color, hardness, fineness, and chemical elements, that were a hundred tons of each thrown into the door yard of Dana, the great geologist and mineralogist, he could not, from any of the characteristics (aside from fossils) tell to which of the two formations either pile belonged.

CLIMATE OF KANSAS.

BY PROF. FRANK H. SNOW.

STATE UNIVERSITY, LAWRENCE, KANSAS, January 1st, 1873.

HON. ALFRED GRAY, *Secretary State Agricultural Society:*

DEAR SIR: In compliance with your request I send you this day the following facts in regard to the climate of Kansas, embodying the results of my own observations since January 1st, 1868. The geographical position of Lawrence is such that these observations may be safely presumed to represent the average meteorological conditions of the eastern half of Kansas. The precise location of this station is as follows: Latitude 38° 58′; longitude 95° 16′; elevation of instruments 884 feet above the level of the sea. The instruments are of the highest standard quality, most of them from the manufactory of James Green, of New York City, maker of instruments for the Smithsonian Institution. In addition to the ordinary apparatus for taking what are called "first-class" observations, the University now possesses and has in successful operation a complete and highly valuable collection of self-registering instruments, by means of which the velocity of the wind, the direction of the wind, the height of the barometer column, and the rainfall, are recorded for every instant of time. This automatic apparatus cannot fail to greatly enhance the value of the meteorological work performed under the auspices of the State University. For example, the determination of the velocity of our Kansas winds will doubtless dispel many vague and exaggerated notions now prevalent concerning this peculiar feature of our climate.

The first element to be considered in our climatology is

TEMPERATURE.

The following table gives the mean temperature of each month and year over which our observations have extended:

Table I.—Mean Monthly Temperature at Lawrence, Kansas.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1868	23.067	35.071	50.091	49.065	66.076	75.005	85.090	74.017	62.037	53.006	37.099	24.022
1869	30. 50	30. 63	35. 07	49. 44	59. 87	66. 86	72. 22	75. 30	59. 93	43. 75	42. 39	36. 92
1870	29. 43	35. 42	37. 69	56. 84	68. 00	73. 71	80. 27	73. 54	67. 88	56. 50	44. 92	28. 70
1871	28. 86	35. 30	47. 42	57. 90	66. 65	76. 85	80. 28	75. 34	65. 16	56. 05	35. 89	24. 91
1872	24. 35	30. 44	37. 23	56. 42	65. 98	76 98	77. 96	77. 27	66. 73	45. 64	43. 36	19. 96
Mean for five years	27. 36	33. 50	41. 66	54. 05	65. 45	73. 89	79. 33	75. 12	64. 41	43. 00	38. 91	26. 95

From the preceding table it will be seen that the monthly temperatures are subject to considerable variation. Thus, March and November are sometimes winter months, while May and September are occasionally summer months. The second half of May and the first half of September almost invariably belong to the summer season.

The mean temperatures of the different seasons, together with the mean annual temperature, are shown in the following table:

Table II.—Mean Temperatures of Seasons and Years at Lawrence, Kansas.

Years.	Spring.	Summer.	Autumn.	Winter.	Year.
1868	55.°077	78.°037	51.°014	27.°089	53.°036
1869	48. 15	71. 17	48. 64	32. 70	50. 36
1870	54. 15	75. 86	56. 43	31. 04	54. 50
1871	57. 32	77. 50	52. 33	29. 50	54. 30
1872	53. 21	77. 40	51. 91	24. 91	51. 90
Mean for five years	53. 72	76. 06	52. 09	29. 21	52. 88

The mean annual temperature, as given in the preceding table, does not differ essentially from that of the States to the east of Kansas in the same latitude, viz.: Missouri, Southern Illinois, Southern Indiana, Southern Ohio, Kentucky, Virginia, and Maryland.

The summers of Kansas, however, are somewhat warmer and the winters considerably colder than those of the states just mentioned, which is to be explained by the fact that the warm winds from the heated, treeless plains on the southwest, and the cold winds from the snow-clad mountains on the northwest, sweep over Kansas with little diminution of their original intensity of temperature.

THE SUMMER SEASON.

The average number of days on which the mercury reached or exceeded ninety degrees during the five summers observed, was thirty-eight. In the cool summer of 1869 there were only twenty-three such days, while in the hot summer of 1870 there were forty-six. But though the thermometer indicates a higher temperature on a greater number of days in Kansas than in States in the same latitude on the east, there are important compensations by which the summer heat is, on the whole, as easily borne as in the eastern States. In July, 1870, for instance, though the mean temperature at 2 P. M. was nearly ninety-one degrees for the entire month, the nights were invariably cool, the mean temperatures at 7 A. M. and 9 P. M. being seventy-four and seventy-six degrees respectively. Another compensation is the constant circulation of the air, which rarely becomes calm in the summer season. Still another, and most important modifier of the heat, is the dryness of our Kansas atmosphere,

which is a general characteristic of the climate and makes the high temperature of midsummer comparatively easy to endure. The greater the amount of moisture in the air, the more oppressive becomes the heat, so that eighty degrees in Philadelphia is more intolerable than ninety degrees in Lawrence.

THE WINTER SEASON.

The winters of Kansas are generally open, the fall of snow being comparatively light, rarely exceeding six inches in depth for a single storm. The average annual depth of snow for the five years observed was 21½ inches, the least amount being 9½ inches in 1870, and the greatest 29¾ inches in 1871.

There is great variation in the severity of our winter months. In 1869 the mercury sank below zero on but two days, the lowest point being only five degrees below zero, while in 1872 the zero point was passed on sixteen days, the lowest point being eighteen degrees below zero, and the mercury being below zero during some portion of the twenty-four hours on eight successive days (Dec. 20th to 27th).

There is also great variation in the duration of the winter seasons. In the winter of 1867–68, farmers were plowing during the whole of December and until the fifth day of January, on which date winter properly began. Uninterrupted cold weather then continued until the twelfth of February, when the winter was at an end after an existence of 38 days. Farmers were plowing again on the fifteenth of February, and there were only five days thereafter (four in February and one in March,) on which the mean temperature fell below the freezing point. The winter of 1871–72, on the other hand, was nearly three months in length, extending from the eighteenth of November to the fifteenth of February. The Kansas river was closed at Lawrence on the twenty-seventh of November and was not opened until the twenty-third of February, a period of 88 days.

KANSAS TEMPERATURE COMPARED WITH THAT OF OTHER STATES.

As furnishing the means of comparing the mean temperatures of Kansas with those of other States, the following table is introduced, which, together with a similar table concerning the rainfall, was prepared by the writer for Mr. C. C. Hutchinson's "Resources of Kansas." These tables were compiled from the observations of the four hundred meteorological observers of the Smithsonian Institution, of whom nearly twenty are located in different parts of Eastern Kansas, including Atchison on the north, Baxter Springs on the south, Leavenworth and Olathe on the east, and Manhattan on the west. Only twenty States are represented in this comparison, those States engaged in the rebellion being omitted because the returns from them for the years 1865, '66 and '67 are too meagre to afford trustworthy results:

Table III.—Mean Temperature of Kansas in comparison with that of other States, from January first, 1865, to January first, 1870.

State.	Spring.	Summer.	Autumn.	Winter.	Year.
Kansas	52.°2	75.°5	54.°3	29.°1	52.°8
Maine	40. 7	66. 4	46. 6	19. 8	43. 4
New Hampshire	41. 7	66. 7	46. 6	20. 4	43. 8
Vermont	40. 4	66. 1	45. 6	18. 4	42. 7
Massachusetts	45. 0	68. 6	49. 7	25. 5	47. 2
Connecticut	45. 0	69. 1	50. 4	25. 8	47. 6
New York	43. 9	69. 7	50. 0	24. 9	47. 1
New Jersey	49. 8	72. 3	54. 3	30. 3	51. 7
Pennsylvania	47. 3	71. 7	52. 0	28. 1	49. 7
Maryland	51. 7	74. 2	55. 6	32. 4	53. 5
Kentucky	54. 4	74. 5	55. 7	35. 2	54. 9
Ohio	49. 4	72. 6	52. 7	29. 1	50. 9
Michigan	42. 4	67. 8	49. 1	24. 2	45. 9
Indiana	50. 4	74. 2	53. 2	29. 7	51. 9
Illinois	47. 6	72. 9	52. 0	25. 8	49. 6
Wisconsin	41. 8	68. 6	47. 8	20. 5	44. 7
Minnesota	39. 4	67. 8	45. 3	14. 0	41. 6
Iowa	44. 5	71. 2	48. 9	20. 3	46. 2
Missouri	52. 5	75. 5	55. 0	30. 7	53. 4
Nebraska	45. 9	73. 4	51. 0	22. 9	48. 4
Mean for twenty States	46. 3	70. 9	50. 8	25. 4	48. 3

RANGE OF TEMPERATURE.

In estimating the influence of climate upon agriculture, it is important to know not only the mean temperature, but also the range of temperature for each month and season. The horticulturist will not wisely place his chief dependence upon a kind of fruit which is liable to be entirely cut off by the extreme cold of winter or the severe frosts of spring. The farmer will not wisely venture his all upon a crop which the intense heat of an exceptionally hot summer would certainly destroy, nor can he safely delay his harvesting beyond the time when the records show the possible occurrence of the first "killing frost" of autumn.

The following table gives the extremes of temperature for each month of the past five years:

Table IV.—Extremes of Temperature for each month at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Month.	1868.		1869.		1870.		1871.		1872.		Mean monthly range.
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	
January	64.°0	—7.°0	56.°0	6.°0	56.°5	—1.°0	67.°5	—5.°0	50.°5	—7.°5	61.°8
February	72. 0	—3. 0	66. 0	—5. 0	69. 0	—4. 0	71. 5	—6. 0	61. 0	-12. 0	73. 9
March	93. 0	22. 0	81. 0	—1. 0	71. 0	1. 0	78. 0	25. 5	72. 0	18. 0	65. 9
April	83. 0	25. 0	87. 0	18. 0	91. 0	19. 0	92. 0	30. 5	85. 0	30. 0	63. 1
May	84. 0	49. 0	88. 0	25. 0	90. 0	44. 0	92. 0	37. 0	88. 0	39. 0	47. 6
June	99. 0	57. 0	90. 0	37. 0	102. 0	44. 0	96. 0	63. 0	97. 0	53. 0	46. 0
July	101. 0	70. 0	93. 0	47. 0	99. 0	55. 0	103. 0	60. 0	93. 5	61. 5	39. 2
August	93. 0	57. 0	96. 0	56. 0	98. 0	53. 0	100. 0	45. 0	97. 0	53. 0	44. 0
September	93. 0	29. 0	85. 0	30. 0	88. 5	53. 0	92. 5	36. 0	94. 0	37. 0	53. 6
October	82. 0	25. 0	78. 0	15. 0	79. 0	29. 0	90. 0	32. 0	92. 0	27. 0	58. 6
November	73. 0	17. 0	72. 0	23. 0	72. 0	17. 0	72. 5	3. 0	67. 0	—1. 0	59. 5
December	53. 0	-16. 5	65. 0	4. 0	64. 0	-10. 0	58. 0	—6. 0	58. 5	-18. 0	69. 0

LONG PERIOD OF ABSENCE OF FROST.

An important point to be noticed in considering the preceding table is the long period of absence of frost. The average date of the last light frost of spring is April 15th; that of the first light frost in autumn is September 25th, giving an average interval of 164 days entirely without frost. The period of immunity from *severe* frosts is considerably longer, averaging 194 days, from about the fifth of April to the fifteenth of October. The April frosts are not often severe enough to materially injure fruit buds. In April, 1868, the thermometer marked seven degrees below the freezing point, but the fruit crop was not damaged, though peaches, pears and plums were in full blossom at the time. In April, 1870, however, on the sixteenth, the mercury fell thirteen degrees below the freezing point and nearly all pears, plums, early apples and budded peaches were killed; while grapes, strawberries and other small fruits were almost entirely uninjured. Of all our leading fruits the peach alone is sometimes fatally affected by the extreme cold of winter, as was the case in December, 1868, and December, 1872. Under ordinary circumstances the peach bud seems incapable of surviving a greater intensity of cold than fifteen degrees below zero. From the two causes already mentioned, the occasional very severe frosts of April and the extreme cold of winter, a good crop of peaches cannot reasonably be expected in Kansas in a series of years oftener than about half the time. Thus, in 1868, 1871, and 1872, this fruit was produced in great abundance, while in 1869, 1870, and 1873 (speaking prospectively of the latter year), the supply was exceedingly deficient, and limited almost entirely to late-ripening seedlings.

The preceding remarks will serve to show the necessity of choosing the best location for an orchard and the best varieties of fruit. A northern slope is preferable to a southern, since in the former location the buds are less liable to be prematurely expanded; the upland prairie is preferable to the bottom lands because the frosts are less severe as elevation above the streams is increased; and those varieties of fruit should take precedence which are most likely to postpone the period of blossoming until after the severe frosts of early spring. The foregoing observations will serve to show that so far as temperature is concerned the climate of Kansas is naturally adapted to the successful production of the great staples of agriculture peculiar to the middle latitudes of the United States. Indeed the long period of freedom from frost, and the prolonged heat of the summer season would seem at least to invite experiment in the culture of crops generally considered to belong to a more southerly latitude.

The second element which demands attention in estimating the climate of Kansas is the

RAINFALL.

The annexed table indicates the amount of rain in inches, including melted snow, for each month of the period under discussion:

Table V.—Rainfall in inches for each month, at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1868	0.36	0.19	3.46	2.95	2.81	3.80	4.05	8.32	4.29	1.58	3.54	2.13
1869	2.90	1.44	1.15	2.43	3.64	7.57	5.05	6.46	4.45	0.69	1.86	0.87
1870	0.67	0.03	1.86	1.08	2.46	1.88	5.58	6.69	2.82	6.96	0.57	0.72
1871	1.11	2.43	1.73	2.38	2.79	4.06	7.30	2.76	1.49	3.58	2.48	1.12
1872	0.17	0.82	2.92	4.74	5.72	1.30	6.50	4.71	2.55	1.95	0.01	1.24
Mean..	1.04	0.98	2.22	2.72	3.48	3.72	5.70	5.79	3.12	2.95	1.69	1 22

The above table shows the peculiar distribution of rain through the different months of the year. Beginning with February, in which the average precipitation is reduced to its minimum, there is a constant increase in each month until July and August, when the rainfall reaches its maximum and begins to decline, each succeeding month showing a decrease in the average amount until the minimum is again reached in February. And while this regularity is seen to exist in the *average* monthly supplies of rain, it will be observed that in no single month of the growing season in either of the five years was the rainfall so light as to interfere in any considerable degree with the proper growth and ripening of the staple productions of the farmer. The comparative amounts of rain for the different seasons and the annual amounts are exhibited in an additional table:

Table VI.—Mean Precipitation of Rain for Seasons and Years at Lawrence, Kansas.

Years.	Spring.	Summer.	Autumn.	Winter.	Year.
1868	9.22 in.	16.17 in.	9.41 in.	2.68 in.	37.48 in.
1869	7.22	19.08	7.00	5.21	38.51
1870	5.40	14.15	10.35	1.44	31.32
1871	6.90	14.12	7.55	4.66	33.23
1872	13.38	12.51	4.51	2.26	32.63
Mean	8.42	15.21	7.76	3.24	34.63

A remarkable feature in the rainfall of Kansas is made evident by the preceding table, from which it appears that only about one-tenth of the annual precipitation occurs in the winter months. In the eastern States the amount of rain, including melted snow, is nearly as large in winter as in each of the other seasons. In Kan-

sas, which has less rain in winter than any State in the Union except Minnesota and Nebraska, the apparent deficiency is abundantly made good by a more copious supply of rain in spring, summer and autumn than is received by the great majority of the other States. In confirmation of this statement, and for a more extended comparison, the following table is introduced, based, like table III, upon the observations of the observers of the Smithsonian Institution, and representing the rainfall in nearly twenty different localities in eastern Kansas. It appears from the table that during the five years from January 1st, 1865, to January 1st, 1870, the average annual rainfall for Kansas was greater than that of the following states: New Hampshire, Vermont, Ohio, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri and Nebraska, (10 States out of the 19); also that the average amount of rain for the spring, summer and autumn months was greater in Kansas than in any of the other States except Connecticut, Maryland, New Jersey and Kentucky; and finally that for the seven months from the first of March to the first of October, when rain is needed for the germination and growth of crops, Kansas stands at the head of the list, having more rain than any of the nineteen States with which the comparison was made. It will be observed that the quantities for Kansas are greater in this table than in tables V and VI, based upon the observations of the writer. This may be accounted for by remembering that the periods of observation are not the same, and that certain other places in Kansas, especially in the southern portion, have undoubtedly a greater rainfall than Lawrence:

Table VII.—Rainfall of Kansas compared with that of other States, from Jan. 1, 1865, to Jan. 1. 1870

States.	Spring.	Summer.	Autumn.	Winter.	March 1st to Oct. 1st	Year.
Kansas	10.82	18.06	9.79	5.42	34.15	44.09
Maine	13.74	10.55	13.33	9.99	28.23	47.61
New Hampshire	10.40	10.49	12.66	7.85	25.40	41.40
Vermont	10.31	10.44	11.82	7.32	25.01	39.89
Massachusetts	13.46	11.17	11.72	10.20	28.71	46.55
Connecticut	13.01	13.34	13.11	10.54	30.88	50.00
New York	11.16	11.19	12.41	9.92	26.85	44.68
New Jersey	13.18	13.88	12.53	11.39	31.81	50.98
Pennsylvania	12.04	12.46	11.17	10.01	29.05	45.68
Maryland	13.67	13.95	12.39	11.22	32.05	51.23
Kentucky	15.18	13.77	9.88	12.50	33.92	51.33
Ohio	12.34	11.73	9.80	8.09	29.24	41.96
Michigan	8.32	9.90	11.00	6.47	23.19	35.69
Indiana	14.35	12.84	10.32	9.27	32.94	46.78
Illinois	11.53	12.07	8.14	6.02	27.92	37.76
Wisconsin	8.92	13.23	8.16	5.87	25.53	36.18
Minnesota	6.09	13.39	8.42	3.78	24.43	31.68
Iowa	10.57	16.72	8.86	6.38	32.14	42.53
Missouri	12.67	13.34	9.29	6.42	30.74	41.72
Nebraska	8.76	12.56	6.25	5.09	24.93	32.62
Mean for twenty States	11.53	12.75	10.55	8.19	28.85	43.02

IS THE RAINFALL INCREASING?

Certain changes have been taking place in Kansas within the the past twenty years which undoubtedly have a tendency to increase the amount of rain. Among these changes, all of which result from the settlement of the State, the following may be mentioned:

First, the plowing of the soil, which is thus enabled to retain a greater proportion of the rain which falls upon it; second, the increase of timber, due to the partial checking of the prairie fires and to the direct influence of settlers in planting trees; and third, the gradual supplanting of the short buffalo grass by the longer and heavier grasses which now prevail in eastern Kansas. It is, however, impossible to present positive proof of the permanent increase of our rainfall, on account of the limited period of observation. The records of at least fifty years would be required to afford a scientific basis for determining this question.

UNIFORM DISTRIBUTION OF RAIN.

Another marked effect of the settlement of a new country would naturally be to secure a more regular distribution of the rain. On this point also, the records are insufficient for positive confirmation. It is, however, the unanimous testimony of the oldest residents of Kansas, that the rainfall is more equally distributed now than ten years ago, coming at shorter intervals and more gently, and that single storms or showers extend over more hours than formerly. My own records at Lawrence show that during the growing season, from March 1st to October 1st, the longest intervals without rain was in the first year of observation, 1868. The rainless intervals for each of the five years were as follow: 1868, seventeen days; 1869, ten days; 1870, eleven days; 1871, eight days; 1872, ten days. From these facts it appears that in neither of the five years was there any approach to a drouth. The number of days on which either rain or snow fell in each year, was as follows: 1868, 77; 1869, 105; 1870, 100; 1871, 120; 1872, 116. This gives an average of 103.6 rainy or snowy days for each year. The average number of such days at Marietta, Ohio, for a period of thirty-two years (1827–1859), was 85.6, and at Brunswick, Maine, for a period of fifty-two years (1807–1859), the corresponding number was ninety-four. (Smithsonian Contributions to Knowledge, vol. xvi.)

SNOW.

Snow is recorded to have fallen as late as April 21st (in 1871), and as early as October 19th (in 1869), but not enough in the former case to whiten the ground. A single fall of snow rarely exceeds

six inches in depth and rarely remains on the ground a week at a time. The heaviest fall of snow was nine inches, which occurred on December 6th, 1868. The following table shows the depth of snow for each month of the five years:

Table VIII.—Depth of Snow in inches for each month, at Lawrence, Kansas, from January 1, 1868. to January 1, 1873.

Year.	Jan.	Feb.	March.	April.	Oct.	Nov.	Dec.	Yearly Amount.
1868	5.00	0.50	0 00	0.00	0.00	6.00	16.00	27.50
1869	4.00	5.25	1.00	1.00	1.25	0.00	5.50	18.00
1870	3.00	0.00	0.00	0.00	0.00	0.00	6.50	9.50
1871	11.00	4.00	4.00	0.00	0.00	5.00	5.75	29.75
1872	1.00	7.75	3.50	0.00	0.90	0.00	11.00	23.25
Mean.....	4.80	3.50	1.70	0.20	0.25	2.20	8.95	21.60

Another important element in climate is the

WIND.

The relative frequency of each of the eight directions of the wind is given in the following table, which embodies 5481 observations. The figures represent the number of times the wind blew from each direction for each year:

Table IX.—Relative Frequency of each Direction of the Wind at Lawrence, from January 1, 1868. to January 1st, 1873.

Year.	N.	S.	E.	W.	N. E.	S. E.	N.W.	S.W.	Calm.
1868	117	228	124	114	92	90	167	141	25
1869	121	243	68	102	95	87	198	126	55
1870	185	325	106	77	56	56	182	71	37
1871	113	225	77	80	72	116	176	193	43
1872	130	255	95	51	88	106	235	116	22
Sums	666	1276	470	424	403	455	958	647	182
Times in 1000....	121	233	86	77	74	83	175	118	118

It will be seen from this table that the south winds (including southeast, south, and southwest winds) outnumber the north winds (including northeast, north, and northwest winds) in the ratio of 434 to 370. At Marietta, Ohio, which is in nearly the same latitude as Lawrence, the south winds also prevail, while at Brunswick, Maine, on the contrary, the north winds outnumber the south winds in the ratio of 503 to 417. In regard to the

VELOCITY OF THE WIND,

Our observations extend over the brief period of six months, from July 1st to December 31st, 1872. During this time the anemometer placed on the north dome of the University building registered

64,828 miles as the entire distance traveled by the wind. This gives an average hourly velocity of nearly fifteen (14.68) miles. The greatest velocity recorded was sixty-five miles an hour from 9 A. M. to 3 P. M. on November 14th. For the sake of comparison it may be mentioned that the mean hourly velocity of the wind at Philadelphia is eleven miles; at Toronto, nine miles; at Plymouth, England, nine miles; at Liverpool, thirteen miles.

FACE OF THE SKY.

The following table gives the average cloudiness in hundredths for each month and year during the period of observation:

Table X.—Mean Cloudiness at Lawrence, Kansas, from January first, 1868, to January first, 1873.

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868	36.13	24.71	51.18	52.00	29.62	41.71	45.96	42.87	46.77	36.34	51.77	49.16	42.35
1869	43.97	51.20	52.81	51.00	46.01	56.74	53.33	45.49	45.44	25.38	62.89	56.56	49.23
1870	49.25	43.69	56.13	49.33	43.87	39.44	30.64	52.80	68.66	54.19	36.83	49.79	47.88
1871	64.00	49.88	52.06	47.11	45.70	46.33	49.79	39.44	34.67	36.77	57.44	45.27	47.37
1872	42.69	54.94	55.06	55.12	55.27	35.33	50.86	33.76	38.33	21.40	44.89	44.30	44.33
Mean..	47.21	44.88	53.45	50.91	44.09	43.91	46.11	42.87	46.77	34.82	50.76	49.02	46.23

It thus appears that on the average a little more than forty-six hundredths of the sky was covered with clouds during the five years of observation. This corroborates the assertion so often made that in Kansas there is a greater proportion of sunny weather than in the Eastern States. In the New England States the average cloudiness is fifty-three hundredths of the sky; in the Southern States forty-seven hundredths; and at Sacramento, California, only thirty-one hundredths; while throughout Great Britain the average reaches seventy hundredths. During our period of observation at Lawrence, the average number of clear days in a year was 157, counting as clear those days on which not more than one-third of the sky was covered with clouds; the average number of half clear days was 89, including under this designation those days on which between one-third and two-thirds of the sky was covered, and the average number of cloudy days was 120, when two-thirds or more were covered. The average number of entirely clear days was 35, and the number of entirely cloudy days was 36.

HUMIDITY OF THE AIR.

The amount of moisture contained in the atmosphere is another important element in climatology. Much has been said in reference to the dryness of the air in Kansas, and on account of this property many invalids have received permanent benefit from a residence in

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1869	4.00	5.25	1.00	1.00	1.25	0.00	5.50	18.00
1870	3.00	0.00	0.00	0.00	0.00	0.00	6.50	9.50
1871	11.00	4.00	4.00	0.00	0.00	5.00	5.75	29.75
1872	1.00	7.75	3.50	0.00	0.00	0.00	11.00	23.25
Mean.....	4.80	3.50	1.70	0.20	0.25	2.20	8.95	21.60

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1871	113	225	77	80	72	116	176	193	43
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1868	36.13	24.71	51.18	52.00	29.62	41.71	45.96	42.87	46.77	36.34	51.77	49.16	42.35
1869	43.97	51.20	52.81	51.00	46.01	56.74	53.33	45.49	45.44	25.38	62.89	56.56	49.23
1870	49.25	43.69	56.13	49.33	43.87	39.44	30.64	52.80	68.66	54.19	36.83	49.79	47.88
1871	64.00	49.88	52.06	47.11	45.70	46.33	49.79	39.44	34.67	36.77	57.44	45.27	47.37
1872	42.69	54.94	55.06	55.12	55.27	35.33	50.86	33.76	38.33	21.40	44.89	44.30	44.33
Mean..	47.21	44.88	53.45	50.91	44.09	43.91	46.11	42.87	46.77	34.82	50.76	49.02	46.23

It thus appears that on the average a little more than forty-six hundredths of the sky was covered with clouds during the five years of observation. This corroborates the assertion so often made that in Kansas there is a greater proportion of sunny weather than in the Eastern States. In the New England States the average cloudiness is fifty-three hundredths of the sky; in the Southern States forty-seven hundredths; and at Sacramento, California, only thirty-one hundredths; while throughout Great Britain the average reaches seventy hundredths. During our period of observation at Lawrence, the average number of clear days in a year was 157, counting as clear those days on which not more than one-third of the sky was covered with clouds; the average number of half clear days was 89, including under this designation those days on which between one-third and two-thirds of the sky was covered, and the average number of cloudy days was 120, when two-thirds or more were covered. The average number of entirely clear days was 35, and the number of entirely cloudy days was 36.

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The amount of moisture contained in the atmosphere is another important element in climatology. Much has been said in reference to the dryness of the air in Kansas, and on account of this property many invalids have received permanent benefit from a residence in

this State. Our observations on this point are limited to the brief period of two complete years, during which time the average relative humidity was 66.4, complete saturation being represented by 100. By this is meant that upon the average the air contained two-thirds of the amount of moisture it was capable of containing. This percentage of moisture forms a very desirable mean between the very moist and the very dry, being alike favorable to the healthful condition of man, the domestic animals and the growing crops. The relative humidity at Philadelphia is 72, the air containing nearly three-fourths the amount of moisture required for saturation.

I have thus briefly touched upon the most important features of the climate of Kansas, as illustrated by my own observations, trusting that these results may lead to a more accurate knowledge of the subjects involved than is generally possessed by the citizens of Kansas and other States.

Respectfully yours,

FRANK H. SNOW,

Professor of Natural History and Meteorology in the University of Kansas.

GEOLOGY OF THE ARKANSAS.

BY B. F. MUDGE.

This paper is based on observations made in the Arkansas valley at various visits during the past five years, and particularly on a trip recently made as far west as Fort Aubrey, near the Kansas and Colorado line. We confine our remarks to that part between Hutchinson and Fort Aubrey, or that portion covered by the red sandstone of the Cretaceous period.

Observations made the past year confirm the statement in one of my papers read before a former meeting of this Association, viz.: that there is in Kansas no geological representation of the formations found in other countries, between the upper Carboniferous measures or Permian, and the Cretaceous. Careful search has been made for fossils of Jurassic and Triassic periods along the western borders of the Permian, and none have been found, while dicotyledonous leaves and other Cretaceous fossils have lately been procured nearer the line of the Permian than during our first collections.

The Arkansas valley, by its fossils, shows the same peculiarity.

The fossils nearest the Permian are Ostrea congesta and dicotyledonous leaves, two species of the latter, found by us a year ago near Fort Larned, being new to science.

Probably it is well known to this association that the outcrop of nearly all of the coal strata of our State have a strike northeast and southwest, and that they can be followed across the State in those directions. This also applies to all strata of the Cretaceous in the northern half of the State. This rule holds true of the red sandstone of the Cretaceous formation, from the Nebraska line in Washington county to Pawnee Rock in the Arkansas valley, but when reaching this valley the rule ceases.

The average breadth of this sandstone in the northern half of the State is about forty miles (northwest and southeast), or about sixty in a diagonal line running due east and west. But when it reaches the bluffs of the Arkansas valley the strike is westerly, and instead of a westerly extension of sixty miles, it covers the whole country from thirty miles east of Pawnee Rock to the western line of the State, a distance of about two hundred miles. This shows that the ocean which favored the deposit of the upper portion of the Cretaceous, so rich in vertebrate fossils, either did not extend in that direction, or from some local cause was not favorable to such animal life. Had the ocean extended in that direction, but was turbid or deep, too cold or too salt, then no chalk deposit would have taken place. Some one at least of these conditions must have existed for a long period.

The sandstone is much varied in condition and appearance. Near Fort Larned and for seventy miles eastward much of it is of uniform texture and hardness, so that it furnishes a good building material. The buildings of old Forts Zarah, Harker and Larned are constructed of it. Care, however, must be used in selection, as much of it is too soft. Farther west it is more loose in texture, so that for thirty miles on either side of Fort Dodge it is too friable and crumbling to be used in forming culverts and buildings, and the railroad now in construction through this valley has frequently been obliged to transport its stone ten or twelve miles. From Fort Dodge to the western line of the State, a distance of 115 miles, the stone is mixed with some lime in a chalky state, which makes the sandstone still more friable.

The strata are not clearly defined in thickness or extent. In some places, particularly west of Dodge, the deposit varies in a great degree. In some spots it is fine, and in others it is mingled with pebbles of flint, quartz, and other silicious stones of the size of the fist. Instances of oblique stratification often occur, usually of coarse

material, showing that the shores of the old ocean had strong local currents. The whole deposit is so nearly horizontal for two hundred miles, that the inclination of the strata, if any exists, could not be detected. The few finely preserved leaves of land plants which have been found, show the existence of islands in the Cretaceous.

Invertebrate fossils are seen at but few points east of Fort Dodge; but in that vicinity and west of it, they are more frequently found. They are restricted to a few species, mostly represented by ostrea and inoceramus. Fossils of a higher type are extremely rare. During two weeks' search, the only specimen obtained was a single palatal tooth of a fish, Ptychodus.

The character of the materials, uniformity, and level state of the deposition, together with the scarcity of organic remains, renders the geology of this part of Kansas the most monotonous we have ever examined.

Such a formation in any part of the world, has never yet yielded any mineral wealth. I make this statement lest any of our new settlers should waste time and capital in a fruitless search for valuable ores. The red appearance of much of the sandstone is caused by iron. In some places this at first sight would raise the presumption that that metal could be procured in paying quantities. This, however, is not the case. While in the best cases the percentage of iron is low, the quality is quite objectionable. The silicates are so mixed with the metal that only a poor article of iron could be sent to market. I make this statement in the face of an assertion made on our visit that a good iron ore of seventy per cent. had been found near Pawnee Rock. But it is equally the duty of a geologist to tell what geological formations do not produce valuable ores, as to point out good localities.

The soil of a country underlaid by such a deposit would naturally be sandy. To a certain extent this is true of the Arkansas valley, but not so much so as to interfere with a good share of fertility. The higher lime strata of the Cretaceous undoubtedly at a former period covered all this part of the State. The abundant fertile elements of those old limestones are intermingled with the present surface soil, and give to it in most places a fine, rich soil. Consequently this valley, to a very large extent, contains excellent farming lands. On the high prairie the black loam is like that in other parts of Kansas, very rich, and from two to three feet in depth. In the valley the loam is from one to ten feet deep, and more intermingled with sand. From Fort Larned easterly, the valley is more or less cultivated, and the crops compare favorably with

other portions of the State. From that place westwardly, the appearance of the soil continues promising. The portion not fertile is confined almost entirely to the south bank of the river, and consists of a belt of sandy hills covered with coarse grass and bushes, and sprinkled with a few trees. These hills will undoubtedly be turned to profit in raising forest trees, to which they appear well adapted.

The only question to be raised in relation to the settlement of the valley is that of rain. This, however, applies only to the country west of Fort Larned. Thus far there have been no forts or settlement for a length of time sufficient to settle this important question. We found some ponds on the high prairies west of Fort Dodge, but the present season has been one of more than ordinary rainfall.

Like all sandstone countries, the water in the wells is good. In any portion of the bottom (in some places fifteen miles wide) it is found at from six to twenty-five feet from the surface.

The contractors of the Atchison, Topeka & Santa Fe railroad sunk "drive" wells at intervals of two or three miles, and uniformly found good water. In only one instance did we learn of a spring or well of alkali water, and that was a few miles from Fort Aubrey.

The river has a very gentle and uniform descent, according to the railroad surveys, of seven feet to the mile. The entire range between high and low water mark is not over five feet. This, on a river averaging one-third of a mile in width, is most remarkable. In this part of the valley it never overflows its banks. The peculiarities of the river, and uniformity of level in the bottom, renders the valley a favorable situation to try the benefits of irrigation. As this method of farming has not been applied in Kansas, we hope some company will be formed to make the experiment.

WHAT IS GOOD FOR AN ARTIST, AND WHAT AN ARTIST IS GOOD FOR.

BY MISS LIZZIE J. WILLIAMS.

Jabez Stockstill's son, Rubens Rembrandt, wanted to be an artist Jabez did not like the idea; not that he objected to giving him every advantage his own hard-earned money could procure, but he wanted him to be a doctor or a minister — something that would be of some use in the world, and not a mere apology for a man. But Rubens Rembrandt was determined to be a painter, and his father was equally determined that if the boy was one at all he should have every opportunity of becoming a first-class one.

Now, the question was: "What is good for an artist?" He did not wish to give him a thorough collegiate course unless it was going to bear upon his work. He could see how a liberal education could benefit a man in any of the learned professions; but of what use it could be to a painter, or what studies he ought to pursue, he was at a loss to decide. In his perplexity he wrote to one of the deepest thinkers in the land, and was told in reply, since his son had already been sufficiently drilled on the farm, in agriculture, to put him through one of our most thorough colleges, then send him to a theological seminary and medical school; let him take a special course on mechanics and engineering, followed by a year's service in the navy (to gain a familiar acquaintance with the ocean in all its forms); then let him acquire the technical part of his profession at Cooper Institute, or some other academy of design, after which he would be pretty well prepared *to begin* the study of Art, provided he had a common amount of talent and an uncommon amount of perseverance.

Mr. Stockstill was considerably mystified by this reply, but thought he comprehended its meaning, viz.: An artist, of all men, should have the broadest culture — at once the most æsthetic and the most practical, the most profound and the most popular.

Take the studies in the curriculum of any of our best colleges— hardly one that does not bear directly upon his life work. What surgeon needs more than he a careful and exhaustive study of Anatomy, without which it is impossible to draw the human figure correctly. It is now taught in all schools of design; the position and play of each muscle thoroughly understood, as well as the skeleton which underlies them. And what Anatomy is to the Figure Painter,

such is Geology to a Landscape Artist. For all the different varieties of scenery, woods with pleasant avenues, sweet footpaths winding through soft pastures, rivulet and river, nestling village, and pines rearing themselves upon the crests of mountains, may be considered as a garment spread by God's hand from one edge of the horizon to the other, and drooping like the folds of a mantle from a King's shoulders. For all this is merely the drapery of the earth, and it again is sustained and shaped by the rocks, as the muscles are by the bones. Therefore the soil cannot be rightly drawn without a scientific knowledge of the rocks which govern it. Again, if one has any ambition to paint trees, (and in what picture do they not occur?) a knowledge of Botany is indispensable. How many pictures have we seen in which it was not only impossible to tell whether the trees represented were oak, pine, palmetto or crab-apple, but where every law of tree-growth was violated, and the result a huge monstrosity and absurdity, calculated to fill the mind with disgust instead of admiration. Either of these two points might be enlarged upon and have been with absorbing interest, by Ruskin, in volumes four and five of his "Modern Painters."

Who would dare to say he had painted water correctly, without an intimate acquaintance with the laws which govern varied forms? These are best investigated by Natural Philosophy, under Hydraulics and Hydrostatics. "Yes," says our friend Mr. Stockstill, "I *can* see how the sciences which investigate *Nature* bear directly on the subject, but what have your pure Mathematics, and your Greek and Latin got to do with the matter?"

Much, every way. Geometry is involved in all Architectural designs; they cannot be demonstrated without it; and Perspective, as difficult a branch of Mathematics as Conic Sections, comes in at every view in which distance is at all considered. In regard to the Classics, nearly all our higher culture in Art is attained by a study of the Antique. What possible veneration can one have for the masterpieces of Phidias or Praxiteles without an acquaintance with the age in which they lived, their manners, customs, literature, thoughts, religion? The Greek Mythology, the most poetic and fantastic which the world has ever known, was the direct inspiration of the statues and has been handed down to us, still unsurpassed, as models of loveliness and ideals of perfect beauty. Who can behold Raphael's frescoes in the Farnese Palace, of Cupid and Psyche, and appreciate half the exquisite design without understanding the Greek Fable? What meaning would that convey to one unacquainted with the mode of Greek thought? How grasp the delicate,

hidden idea embodied in the statues of the Venus di Medici, the Venus di Milo, (to properly introduce which, Baron Grimm has written so many æsthetic and metaphysical essays,) the Apollo Belvedere, Michael Angelo's "Bacchus," the Farnese Hercules, the Minerva of Phidias, or the writhing agony of Laocoon? It can only be done by placing ourselves as nearly as possible at the Greek standpoint. To accomplish this, *one* method alone remains to us,—a careful study of Greek Literature. The spirit of the age, it seems to me, is making a great mistake in throwing this element of culture out of its practical education; however this may be, to one who aspires to *high* Art such culture is of inestimable value.

We have now completed the curriculum of an ordinary college, and found every department bearing directly toward the end we have in view for our young friend, Rubens Rembrandt. Not that he should complete all these studies before venturing upon the practical; let him cultivate his hand at the same time with his intellec, and taste. Only let him learn through the crayon and brush, facile and ready expression of the ideas these studies have been developing, and he *cannot help* being an Artist. But with all the heir-ship of genius Nature has bestowed as a birth-right, and all the mechanical dexterity attained by patient practice, without these mental acquisitions he will never become an artist, but will forever remain a mere Artisan.

Further, Mr. Stockstill's adviser said that having completed a collegiate course it would be of advantage to Rubens Rembrandt to study Divinity. Doctrinal Theology, perhaps not; (it is a question whether it is an advantage to our clergymen;) but a close study of the life and teachings of Christ, emphatically, *yes*. Nearly all of the great Artists have modeled their lives after His. What more lovely than the sweet, calm enthusiasm of the cloistered life of Fra Angelico. a saint as truly inspired as the Apostle John; for each in his cloistered life saw the heavens opened, and left behind him records of his beatific visions. What more grandly sublime than the unapproachably heroic, and self-sacrificing life of Michael Angelo? Steadfast, unmovable, strong to endure, mighty in power, misunderstood and solitary save when "an angel was sent to strengthen him." An Artist's sympathy with his race must be broad, out-reaching like that of his Master's. If he could catch the most delicate expressions of feeling, and transfer them to canvas accurately, he must be "a partaker of the Divine Nature," an apt scholar of the Great Teacher. True there have been Artists of dissolute lives; their works show it; but all these "died young, or painted ill when old."

Our sensible, practical friend, Mr. Stockstill, asks another question: "What is an artist good for?"

After I have given Rubens Rembrandt the expensive education you advise, and the advantage of Art-school besides, of what earthly use will he be in a busy, work-a-day world like this? Will he be an ornamental superfluity, only fit to talk "tone, old masters, the Renaissance and pre-Raphaelitism" in the drawing-room, or a wild enthusiast who never combs his hair, and taking a great white umbrella, plants himself in some waste and solitary place, daubs furiously canvases which unpainted cost $2.50, and painted cannot be sold for twenty-five cents? Nothing of the sort. After leaving the halls of his Alma Mater he will be ready and proud to step into a carpenter's shop, and having served a short apprenticeship at the bench, a new sign will appear on one of the streets of your village, R. R. Stockstill, Architect and Builder, and that town will owe more to you in the gothic arches of its churches, its commodious school houses, imposing court house, elegant music hall, palatial villas and exquisite gems of cottages,—a thousandfold more to you, sir, or to the education you have given your son, than if you had invested the money it cost you in city bonds and burned them on the spot.

Or he may become an inventor of machinery, and by some lucky patent make all your fortunes. Or he may become a Bridge Builder, or a Designer, and of this class the name is legion. I will enumerate only a few of the different departments, in each of which there is a steady demand for designers of cultivated artistic tastes. First, Engravers and chasers in gold and silver. A lady in Philadelphia has laid by a snug little fortune by chasing the backs of gold watches. She easily earned $1 per hour. It is light work, but requires skill in drawing. There are but few first-class engravers, and the demand for engraved jewelry and silverware is on the increase.

Another branch of the same business is that of the lapidary and cameo-cutter. There are two kinds of cameo-cutting—one with a lapidary's wheel of hard stones, as the onyx and the sardonyx; but the more common are the shell-cameos, which are cut with small steel chisels from the white portion of the shell, leaving the chocolate color for the back ground. In Mrs. Lee's "Sculpture and Sculptors," we find an account of those who have engaged in cameo-cutting in the United States. Then we have ivory cutters and pearl-workers, and workers in the Intaglio and Mosaic. "A great deal of money is expended on monuments, but there is a lack of variety in the designs," and marble, under any circumstances, is a noble field for the artist.

Plaster statuary, we are told from reliable authority, gives lucrative employment in our large cities, to those who are adept in geometrical figures and drawing. Inventive talent finds a ready field for exercise, while the study of architectural ornaments and books is a great advantage to an expert with a pencil. Designers are employed in all glass companies, in carpet factories and calico mills. In these departments a person of lively fancy and nice powers of discrimination succeeds best. Gay, rich, dark colors are not suitable for summer, nor light, delicate shades for winter. Designers of quick perception originate the most tasteful dress goods. In the Report of the Philadelphia School of Design it is stated that one of the ladies of that school received $60 for a design for wall-paper; they seldom bring so much, however, the usual price being from $12 to $20. This is almost entirely monopolized by the French. One leading manufactory gets its patterns from the School of Design in Paris, and another New York firm pays a Frenchman $1,000 a year, the same man receiving $3,000 per annum for designing in another manufactory.

China decorators and porcelain painters are finding employment in the United States, though for want of cultivated and imaginative designers the European work still excels in beauty and elegance. The porcelain of Japan is most durable, that of France most ornamental. The delicate lace-work in Dresden china is executed by women. In all these departments the demand is not so much for mere mechanical skill as for highly cultivated ideas and refined tastes that give back their own image; as "Nature is the glass reflecting God."

Fresco painting is becoming a steady employment in our larger cities, and requires a wide range of culture, as well as a vivid conception for the artist to become eminent in the profession. Landscape gardeners are loudly called for. These can only distinguish themselves by being in harmony with nature and diversity of climate —a field as vast as the globe, embracing a knowledge of both vegetable and animal kingdom, without which most egregious blunders will occur. Mr. Demas "Ignoramus" paid a fabulous sum for one of God's master-pieces on College Hill, Cincinnati. The creator had terraced its slopes with His own hand, planted the red-bud and hung the scarlet bitter-sweet, which are unsurpassed in beauty in Ohio. Nothing was wanting, save a few statues of native, wild animals artistically interspersed, to keep the landscape intact. What does the barbarian do, but order his gardener (a man of far more culture than himself) to cut down his most valuable trees and fill up the ravine to a dead level.

Lithographers, steel engravers, copper-plate engravers, map engravers, bank-note engravers, card engravers, seal engravers, and so forth ad infinitum, are in constant demand. The Director of the Pennsylvania Academy of Fine Arts says: "*Skill* in drawing is a key that admits to a wider range of art than I can readily enumerate, and successful and profitable employment in engraving depends on *that*." Further, he says that "Whatever branch of the Fine Arts is to be followed, there are three requisites. The first is drawing, the second is *drawing*, and the third is DRAWING." In short, the industrial appliances of art are almost innumerable. The occupation into which it does not enter to some extent is an exception. Take a very simple example. Color-blindness is a more common misfortune than ordinarily supposed. The colors generally confused are green and red; yet these are the very ones used as railroad signals. So that a great railroad catastrophe may be the result of a locomotive engineer not having "an eye for color."

It is little estimated how much Art has to do with the politics of the day. The Tammany Ring owes the contempt now felt for its corruption principally to Nast's caricatures of Tweed, Sweeny, and others.

Mr. Greeley's defeat was in a great measure owing to the comic pages of the illustrated newspapers.

This power of caricature may be more fully appreciated by a study of the Masters in this department.

Cruikshank, the accepted portrayer of Dickens's characters—Gustavus Dore, is unrivaled here. Chane, the author of the comicalities in Le Mode Illustri, is intensely humorous, while nothing can equal the delicate *wit* of Paul Kanewka's Silhouettes. The artist who takes off society life for Punch is irresistible.

The close connection that exists between Art and Literature is shown by the fact that so many authors illustrate their own works. Hood did so, and Thackeray is almost as noted an artist as an author. It would be hard to tell in which department to class Ruskin. Indeed, the same qualities and the same culture are required for each; both must be keen observers and highly imaginative. Take a dirty roadside pond as an example. An ordinary man knows that it is muddy and sees nothing but mud, and would express it on canvas by a great brown daub.

"A great painter sees beneath and behind the brown surface what will take him a day's work to follow, and he follows it, cost what it will. He sees it is not the dull, dirty, blank thing which he supposes it to be; it has a heart as well as ourselves, and in the bottom of

that there are the boughs of the tall trees and their quivering leaves, and all the hazy passages of sunshine, the blades of the shaking grass with all manner of hues of variable, pleasant light out of the sky; and the bottom seen in the clear little bits at the edge, and the stones of it, and all the sky, and the clouds far down in the middle drawn as completely and more delicately they must be than the real clouds above. For the ugly gutter that stagnates over the drain-bars in the heart of the foul city, is not altogether base; down in that if you will look deep enough you may see the dark, serious blue of the far off sky and the passing of pure clouds. It is at your will that you see in that despised stream either the refuse of the street, or the image of the sky; so it is with many other things we unkindly despise." A painter who is a nice observer enough to notice all this, will be equally exact and discriminating in all his observations; ten to one he will be as ready in giving you a verbal account of them, as in a pictured one. Ergo, a good Artist should be an entertaining writer and an eloquent orator. Indeed, I can think of nothing with the exception of religion, as remarkable as Art for its universal adaptability, its all-preserving character. To the poor a means of support and source of rich enjoyment. To the scholar opening fields of critical study and connoisseurship, cultivating the tastes of the rich, so that their wealth is not mere vulgar display, but made the patron of luxury, which is æsthetic, and elegance which is the perfection of loveliness.

If, like religion, it enters into all our humdrum cares, beautifying our homes and glorifying the humblest occupation, what then must be the happiness of one allowed to minister as priest in the Holy of Holies, and leaving the application, devote himself exclusively to High Art? I maintain there is but one vocation equal in beauty, in honor and sacredness, to that of the Artist. That *one* is the Christian Ministry. Men there are who disgrace both callings; it seems to me to be worthy of either, a man should devote his life to the work, and be filled with such a holy passion, such a calm but overmastering enthusiasm that nothing earthly—fame, friends, fortune, happiness, applause, high honor, even love—these, or the loss of any or all of them should materially affect him. Nay, he should be able to say with the Apostle Paul, "I am persuaded that neither death, nor life, nor angels, nor principalities, nor powers, nor things present, nor things to come, nor height, nor depth, nor any other creature, shall be able to separate me from the love of God as manifested in my most sacred calling."

Only an amateur as yet, standing as a novice at the outer gate, it

is my high ambition some day to serve within thy temple, O Art! and to add imperfect and faulty, but loving, work to that of the noble army of Artists who still praise thee.

AGRICULTURAL COLLEGE, MANHATTAN, KAN., October, 1872.

METEOROLOGICAL SUMMARY FOR THE YEAR 1872.

By Prof. F. H. Snow, of the Lawrence State University.

Station, Lawrence, Kansas. Latitude 38° 58′; longitude 95° 16′. Elevation of the barometer and thermometers, 884 feet above sea level and 14 feet above the ground; rain gauge on the ground; anemometer 105 feet above the ground, on the dome of the University building.

TEMPERATURE.

Mean temperature of the year, 51.90°, which is 1.23° lower than the mean temperature of the four preceding years. Mean temperature of the winter months, 24.91°; of the spring, 53.21°; of the summer, 70.40°; of the autumn, 51.91°. The winter and spring were each four degrees colder, and the summer and autumn were each less than half a degree cooler than the corresponding seasons in the year 1871.

The mean temperature of the year 1869 was 1.54° lower than that of 1872, but in the former year the winter months were much warmer. and the summer much cooler than in the year just completed.

The mean temperature at 7 A. M., 44.89°; at 2 P. M., 61.14°; at 9 P. M., 94.65°. The highest temperature was 97°, June 26 and August 26; the lowest, 18° below zero, December 20 and 24—giving a range of 115° for the year. The mercury fell below zero on 16 days, January 28, 29, 30 and 31, February 3, 6 and 7, November 29, and December 20 to 27, inclusive. The "cold snap" in December was the severest and longest continued on our record, the mercury on one occasion remaining below zero for 50 consecutive hours. The month of November was even colder than in 1871, the mercury sinking below zero for the first time on record for that month. Winter weather began November 13th, five days earlier than last year, and the Kansas river was closed on the 29th, two days later than last year. The coldest month of the year was December, with mean temperature of 19.93°; the coldest week was in December, (20th to 26th, inclusive,) the mean temperature being only one-twentieth of a degree ab-

zero, which is 7.91° colder than any previous week recorded; the coldest day was December 24th, the mean temperature being 9° below zero. The 21st, 23d and 24th of December were each colder than the coldest of previous years.

The hottest month was July, mean temperature 77.96°; the hottest week was in August (21st to 27th inclusive), mean temperature 83°; the hottest day was June 26th, mean temperature 85.7°. During the year there were forty-five days on which the mercury reached or exceeded 90°, viz.: Fourteen in June, eleven in July, thirteen in August, five in September, and two in October. The last light frost of spring was April 22d; the first light frost of autumn was September 27th, making the period of entire absence of frost 158 days. It is remarkable that this period is precisely the same, and with the same dates of beginning and ending, as in 1871. The last severe frost of spring was April 1st; the first severe frost of autumn was October 10th, making the interval of absence of severe frost 192 days. No spring or autumn frost did any damage to fruit. The extreme cold of December, however, has undoubtedly killed the peach buds in most localities.

RAIN.

The whole amount of rain, including melted snow, 32.63 inches, which is 2.50 inches less than the average rainfall of the four preceding years. During the year there were 116 days on which either rain or snow fell, a larger number than in any previous year of our record. The longest interval without rain in the growing season, from March 1st to October 1st, was ten days. The number of thunder showers during the year was forty, a greater number than in either of the four preceding years.

SNOW.

The entire depth of snow was 23¼ inches, distributed as follows: January, 1 inch; February, 7¾ inches; March, 3½ inches; December, 11 inches. The last snow flurry of spring was March 24th; the first autumn snow was November 14th, not enough to whiten the ground on the latter date. Snow fell on twenty-five days—four days less than in 1871. The entire amount of snow, as given above, is 6½ inches less than fell in 1871, which was the snowiest year of our record. The average annual snow fall for the five years just completed is 21.6 inches, the least amount being in 1870—9½ inches.

FACE OF THE SKY.

Average cloudiness of the year, 44.28 per cent. of the sky, more than 3 per cent. less than in 1871. The number of clear days in the

year was 168, counting those days clear on which the average cloudiness did not exceed one-third of the sky; the number of half clear days was 93, including under this designation, those days on which between one-third and two-thirds of the sky was covered with clouds; the number of cloudy days was 105, when two-thirds or more was covered. There were thirty-four entirely clear days, without a trace of a cloud; there were only twenty-three entirely cloudy days, without a trace of sky. May was the cloudiest month, when the average cloudiness was 55.27 per cent.; October was the clearest month — the clearest in five years — only 21.40 per cent. of the sky being clouded. The mean cloudiness at 7 A. M. was 47.79 per cent.; at 2 P. M., 48.06 per cent.; at 9 P. M., 36.99 per cent.

WIND.

During the year (three observations daily), the wind was from the south 255 times, northwest 235 times, north 130 times, southwest 116 times, southeast 106 times, east 95 times, northeast 88 times, west 51 times, calm 22 times.

It will be seen that the south winds (including southwest, south and southeast), outnumbered the north winds (including northwest, north and northeast), in ratio of 477 to 453. This preponderance of the south winds has existed in each of our five years of observation. In New England, the north winds largely outnumber the south winds.

Observations upon the velocity of the wind were made during the second half of the year. During the six months, the anemometer on the north dome of the University building, registered 64,828 miles as the entire distance traveled by the wind. This gives an average hourly velocity of 14.68 miles. The average at Philadelphia is 13 miles an hour.

The highest velocity during the six months was 60 miles an hour, from 9 A. M. to 3 P. M., November 14th, on which day the wind traveled 1,050 miles.

BAROMETER.

Mean height of barometer column, 29.112 inches. Mean at 7 A. M., 29.137 inches; at 2 P. M., 29.089 inches; at 9 P. M., 29.111 inches. Maximum height, 29.779 inches, at 9 P. M., November 28; minimum, 28.401 inches, at 2 P. M., April 6; range for the year, 1.378 inches. The highest monthly mean was in December, 29.299 inches; the lowest was in April, 28.999 inches.

RELATIVE HUMIDITY.

Mean for the year, 64.4, that is, the air contained on the average, less than two-thirds the amount of moisture necessary for saturation

this being a very healthful mean. The mean at 7 A. M. was 75.49; at 2 P. M., 46.72; at 9 P. M., 71.08. There were eleven fogs during the year. October was the dryest month—humidity 53.69; July was the dampest month—humidity 75.2. The least amount of atmospheric moisture observed was at 2 P. M., April 12th, when the relative humidity was only 9.2, less than one-tenth of saturation.

The following table gives the mean temperature, the extremes of temperature and the rainfall for each month of the year 1872 :

Month.	Mean Temperature.	Max'm Temperature.	Min'm Temperature.	Rainfall in Inches.
January	24.35	50.5	—7.5	0.17
February	30.44	61.0	—12.0	0.82
March	37.23	72.0	18.0	2.92
April	56.42	85.0	30.0	4.74
May	65.98	88.0	39.0	5.72
June	76.98	97.0	53.0	1.30
July	77.96	93.5	61.5	6.50
August	77.27	97.0	53.0	4.71
September	66.73	94.0	37 0	2.55
October	55.64	92.0	27.0	1.95
November	33.36	67.0	—1.0	0.01
December	19.93	58.5	—18.0	1.24
Year 1872	*51.90	97.0	—18.0	32.63
Year 1871	54.30	103.0	—6.0	33.23
Year 1870	54.50	102.0	—10.0	31.32
Year 1869	50.36	96.0	—5.0	38.51
Year 1868	53.36	101.0	—16.5	37.48

*The yearly means are not found by dividing the monthly means by twelve, which would be correct if the number of days in each month were the same; but by dividing the sum of all the observations by the actual number of observations (in this case 1,098).

TRANSACTIONS

OF THE

SIXTH ANNUAL MEETING

OF THE

Kansas Academy of Science

(1873)

WITH REPORTS OF THE SECRETARY.

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REPORT OF THE KANSAS ACADEMY OF SCIENCE.

At the last session of the Legislature, the Kansas Academy of Science was incorporated as a State organization by the following act:

"The Academy of Science shall be a co-ordinate department of the State Board of Agriculture, with their office in the agricultural room, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the fifteenth day of November, of each year, to the State Board of Agriculture, for publication in the Annual Transactions of said Board. This section to be inoperative and void unless accepted by the said Academy of Science, in writing, signed by the president and attested by the secretary thereof." [Chapter 137, Sec. 2.]

The people of the State have thus indicated their appreciation of the aims and work of the Society, by incorporating it as a State institution.

The year has been fruitful to the cause of science in the State, in many respects.

Professor B. F. Mudge, of the State Agricultural College, has discovered, in Osage county, fossil footprints, of which a paper containing a full synopsis is appended. This is probably the most important discovery ever made in science in the State of Kansas, and will add a laurel wreath to the well-earned reputation of this veteran geologist. The discovery has already elicited a wide interest in scientific circles in the East, and several tons of the specimens have been ordered for Eastern cabinets.

Professor Frank H. Snow, of the State University, has continued to publish his carefully prepared meteorological reports, at Lawrence. The University has been provided with a full set of self-registering instruments for meteorological purposes, and there is a good prospect that it will be made a signal station.

Professor J. H. Carruth has continued his observations on the plants of Kansas. He writes in substance:

"I have become acquainted with twenty-one species that I gave last year on the authority of Profs. Snow and Hall. The year past I have studied more the hedge plants and grasses. I have found the garden gooseberry to be *Ribes hirtellum*, native in the country, but not wild in Kansas. My list of plants for the year, which I send, is to be increased by the observations of Prof. Snow, who has added about eighty species. Prof. John Wherrell collected all summer, and will add some; also, Mr. E. A. Popenoe. Prof. B. F. Mudge has sent me some specimens, and Mrs. Craig, of Quenemo, has brought me

a tassel not in the books. I have found two which Prof. Wood thinks are new, viz.: an Asclepias, one foot high, with a single nodding umbel, and a Rosa, with lone stem quite prickly; leaflets, about nine, and flowers about ten, and fruit mostly conical."

Prof. Wood proposes to name these plants after their discoverer as a recognition of his long and unrewarded service in this department of science Prof. Carruth has also discovered some undetermined plants which may prove to be new to science. Other members of the Academy have been laboring faithfully in their respective departments, the fruits of which appeared abundantly at the annual meeting.

The need of a more thorough scientific survey of the State is being felt in various ways by the people. The State, for example, possesses the most ample water powers along its numerous streams for manufacturing purposes. Could these be determined by a competent engineer, and utilized, it would result in an immense saving to the State. Science thus applied to the practical affairs of life yields rich returns to any people.

PROCEEDINGS OF THE SOCIETY.

The sixth annual meeting of the Society was held in the University building, at Lawrence, on September 8th and 9th, 1873, and was largely attended by the scientific men of the State. The papers read before the Society were of unusual merit, and the proceedings elicited a very general discussion in the public journals. There was such a pressure of papers and business before the Society, that the President suggested the necessity of resolving it into sections, as is customary in larger scientific associations, so that all the papers presented could be reap.

The following transactions of the Society are of public interest:

The subject of auxiliary societies was introduced, discussed and approved, and a committee composed of F. H. Snow, B. F. Mudge and F. E. Stimpson, was appointed on the same. The Topeka Scientific Institute was admitted as an auxiliary society.

The attention of the Society was called to the subject of standard weights and measures for Kansas, and the following resolution was adopted:

"*Resolved*, That a committee of three be appointed to consider the question of standard weights and measures for the State, and to report some recommendations to the Legislature of the State during the next session — reporting as a committee of this Academy, F. W. Bardwell, F. E. Stimpson, and Robert J. Brown."

The following papers were read :

On the Action of Lime on Soils, by Miss Jennie Detmers.
On traces of the Mound Builders in Kansas, by B. F. Mudge.
On Meteors between the sixth and thirteenth of August, by John Fraser.
On Tornadoes, by John D. Parker.
On the Composition of Comet's Tails, by F. W. Bardwell.
On our Public Works, by William Tweeddale.
On the Lepidoptera of Kansas, by F. H. Snow. (This paper was illustrated by a large collection of butterflies and moths, very neatly mounted in trays.)
On Explosive Mixtures, by F. E. Stimpson.
On Fossil Footprints in Osage county, by B. F. Mudge.
On the Coleoptera of Kansas, by Edwin A. Popenoe.
On the Climate of Kansas, by F. H. Snow.

The following public lectures were delivered:

On Darwinism, by Peter McVicar, D. D.
On John Dalton, or the Quaker Man of Science, by Charles Reynolds, D. D.

The following officers were elected for the current year :

President, Frank H. Snow; Vice-Presidents, John A. Banfield, John D. Parker Secretary, John Wherrell ; Treasurer, Robert J. Brown ; Curators, Frank H. Snow, B. F. Mudge, and Edwin A. Popenoe.

The following commissions were confirmed for the current year:

Geology — B. F. Mudge.
Ornithology — F. H. Snow.
Entomology — F. H. Snow, Edwin A. Popenoe.
Language — D. H. Robinson, J. H. Lee.
Engineering — F. W. Bardwell.
Technology — F. E. Stimpson.
Astronomy — John Fraser.
Meteorology — John D. Parker.
Botany — J. H. Carruth, John Wherrell, F. H. Snow.
Mineralogy — W. K. Kedzie.
Chemistry — William H. Saunders.

Society adjourned to meet Monday evening, September 7, 1874, at Topeka.

SYNOPSIS OF PAPERS.

TRACES OF THE MOUND BUILDERS IN KANSAS.

BY B. F. MUDGE.

Few traces of the old mound builders are found after passing fifty miles west of the Mississippi river. No mounds have been found in Kansas, and the few traces of their villages are very obscure. The object of this paper is to draw attention to the subject, that others may be induced to notice and record any fact within the

bounds of our State which will throw light on the existence of this ancient race.

About half a mile from the crossing of the old Santa Fe trail at Cow creek, in Rice county, are seen the remains of pottery, etc., showing that at least a temporary village formerly existed at that spot. The area covered is small, and the pottery very fragmentary.

In the extreme northeastern corner of Riley county, on a farm, we found fragments of pottery, arrow heads and other stone implements, and also the clippings of stone left where the implements were made. The area covered over twenty acres, and is a very pleasant locality for a small village. There is a fine spring near, and plenty of running water at all seasons in the creek. This locality was drawn to my notice by J. M. Morris, Esq., county treasurer, who presented me with fragments of various utensils collected from the spot.

But the most important locality seen by us in Kansas lies not far from Asher creek, on the southwesterly side of the Solomon river, in Cloud county. The locality is on a rolling prairie, just above the river bottom, which is here quite narrow. The most marked feature of this village is the pottery, where their domestic articles were manufactured. It (the pottery) covers an area from one-fourth to half an acre, rising irregularly at the highest point about two feet above the level of the adjoining prairie, and is composed to a great extent of the materials and debris from the old workshops. In it we found a considerable quantity of the clay dug from the banks of an adjoining ravine, which had never been moulded; some partly moulded, and sometimes mixed with straw, probably to be used in the coarsest articles. Also, fragments from what appeared to be the ovens in which the pottery had been baked. These fragments showed marks of fire, and were too clumsy and coarse to have been part of any household utensil, and were mostly in a heap in the highest and central part of the pottery.

The extent of the village was obscure, as the rank grass covered the ground for long ages, and nearly obliterated all traces of what once existed. That these villages were made by mound builders, appears evident from the appearance of pottery. Not only is the texture similar, but the ornamental markings are like those described by Foster and others. The peculiar figures seen on the vessel, figure 43, page 244, of Foster, are frequently seen. Also, the clearly defined marks as made by moulding the vessel on the inside of baskets. There were "ears" on fragments of the larger vessels, as if designed for bails.

These few traces of the ancient race which preceded our Indians show that the mound builders never visited this region in large numbers, or made very permanent towns. They were probably some of the remote settlements on the outskirts of their civilization, represented by our pioneers, provided our population should cease to extend its advance—a few of their tribes who chose to live where free range of territory was more congenial to their habits than the more densely settled portions of the Mississippi and Ohio valleys, where so many of their large mounds are seen.

RECENT DISCOVERIES OF FOSSIL FOOTPRINTS IN KANSAS.

BY B. F. MUDGE.

About the 1st of July, in crossing Kansas avenue, Topeka, we noticed, on a slab of the flagging, clearly defined footprints of reptiles. There was no hesitancy in referring the stone to the quarries of Crane & Dodd, of Osage. Taking the next train to that place, and carefully examining the quarries, a mile apart, we were well rewarded for our trouble.

The flagging at the new quarry consists of four principal layers, respectively one and a half, two, three, and four inches in thickness, interlaid usually by thin seams of soft shale. The flagging is fine-grained sandstone of close texture, coming out in slabs sometimes ten feet by twenty-five.

At the old quarry, the layers are not so distinct. The slabs, as they are quarried, are frequently inclined to split in thin sheets, some of which are marked by footprints. The best of the smaller ones were thus obtained, giving a fine specimen of footprint and cast.

The deposit is just above the middle of the coal measures, and about a dozen feet above the coal seam worked at Carbondale and Osage. The slabs or layers containing the footprints afford but few fossils, although there are numerous fucoidal impressions with ripple-marks. But immediately above and below the flagging, are calcareous strata containing abundant remains of the usual marine fossils of the period.

We have selected thirty slabs containing footprints, for preservation, there being a few others too poor to pay for removal. Most of these contain but one set of tracks, but several contain two of different species, and one has four sets.

The most common footprints, represented by more than half of all that were found, were large, saurian-like tracks, in character and shape a little like Polemarchus gigans of Hitchcock. It differs in being but two-thirds as large, and in the proportional length of the toe and heel. In our species the toes are all nearly of the same length, five inches, and the heel four inches, making the total length nine inches. The width of the heel is five inches. There are some indications of a fourth short lateral toe. The length of the stride is from twenty to twenty-two inches. Width of the trackway, from center to center of the footprint, is from four to six inches. There are about twenty slabs marked by this species, some of which are very poor. The number of footprints on the slab varies from two to twenty.

The tracks of this species differ much in size, so much so that I was at first inclined to consider them of two species; but I now class them as old and young individuals. On the largest slab, the smaller (there being three rows of tracks) are half the size of the larger, and it will be no great stretch of the imagination to suppose that in this case the mother was followed by her offspring.

Over two hundred footprints of this species were seen, and all found in the four-inch flagging. They are all casts. The outline of the foot in this species is indistinctly defined, rendering its description and identification very difficult. The reason that no direct footprints were discovered was very apparent. The layer on which the animal walked was a soft clay, which did not harden, but crumbled in removal of the layer above. But the latter being of fine sand and a small trace of lime, took the print of the footstep and hardened to stone. For sidewalks this layer is the most durable, and is in demand where large and firm slabs are desired. In several places on Kansas avenue, Topeka, the slabs show where the raised casts of the footprint have been taken off by the stone-mason to give an even surface. Their relative position can still be easily traced.

Another footprint is that of a smaller animal, the foot measuring by the toes about two inches in length — heel not discovered. Number of toes, four, the fourth being small and obscure. A lateral spur was found in a few instances. Length of the stride, twelve inches, and width of the trackway from center to center, six inches. These tracks were found on six slabs, and on several solitary pieces at three different quarries. Some were also obtained by splitting the larger slabs from the old quarries. The footprint and cast of the same track were, in such cases, obtained. In several instances

the lobes of the toes were distinctly seen. The general impression left after a study of this species is, that the animal must have been a clumsy reptile, with some of the traits of both frog and salamander. The number of tracks seen on single slabs varied from one to sixteen. About one hundred and fifty tracks of this species were procured.

The best and most distinctly preserved tracks are those resembling the Cheirotherium. These are found at what is called the "Old Quarry." These tracks are very clear in the outline of the front toes, but the heel is obscure. The outline of the foot appears to have been four and a half to five inches wide, and in length five and a half. The length of the stride is from twenty one to twenty-two inches. The hind footprint usually covers the heel of the fore foot. We obtained both the true track and the cast. The width of the trackway is eleven and twelve inches, measuring from center to center. The front foot has four toes, the hind foot five, the fifth being short and perhaps rudimentary. The footprint shows that the animal in walking rested his weight mostly on the toes, as these are strongly and clearly impressed, while the heel can be traced with difficulty. In several instances the wrinkle of the skin could be seen. No trace of a claw was visible. In plumpness the toe resembles the Cheirotherium, the toes being more divergent. It also resembles the foot of the Saurotus primevus, found in the sub-carboniferous of Pennsylvania, but is clearly an animal differing from both. We procured twelve slabs of this species, and a few single tracks. From four to sixteen footprints were found on each slab, numbering in all about one hundred.

These footprints are as distinct and clear as the average of those found in the sandstone of the Connecticut valley. They are sufficiently perfect to give the characteristics of the feet of these animals and their modes of progression, from which they can be reconstructed.

We found also five small tracks somewhat like the above, measuring three-fourths of an inch in length by one and a fourth in breadth. This was not enough to decide the character of the animal.

On one slab are two prints very much like a mule's foot, or, rather, his shoe. A similiar mark has twice been described (in Europe and America), as a footprint; but recent investigations have decided that it is the impress of a fucoid or marine plant.

We have here four distinct species, all probably different from those previously discovered, from other parts of the world. They also are valuable from the fact that few footprints are found west of

the Allegheny mountains. Their geological position down in the coal measures also adds to their scientific value. We have not given so detailed a description of them as is necessary for identification of species, as some of them will go to Yale College, and there be compared with their large collection, and Prof. Marsh will then proceed to assign their true paleontological character and name them. I have compared them with known footprints of the Connecticut valley, and have been surprised at their apparent resemblance; yet, when we recollect that those are *triassic*, while ours are in the middle of the coal measures, it seems most probable that they are generically distinct, and will add new races to the earliest air-breathing animals of our globe.

REPORT ON THE BOTANY OF KANSAS FOR THE YEAR 1873.

BY J. H. CARRUTH.

During the past year I have devoted what time I could spare from other duties to a further examination of the Plants of Kansas, and herewith give the result. Some cases doubtful last year have been solved, and I have become acquainted with twenty or more of those given last year on the authority of Professors Snow and Hall.

The past year our corps of observers has been much increased. In addition to Prof. Snow, we have had Prof. Wherrell, of Leavenworth; Dr. Saunders, of Lawrence; Mr. Popenoe, of Topeka; and Dr. Watson, of Ellis; to whom the proper credits will be given. The latter gentleman has given thirteen, none of which are found in Wood's Class-Book or Gray's Manual.

It is sometimes asked: Of what use is botany to a farmer? I have repeatedly known persons to set out wild grape vines, and look two or three years for fruit, when the blossoms had stamens or male organs only, and could never produce fruit. Some grape vines from seed have perfect blossoms; that is, both stamens and pistils, and some have stamens only. But vines from cuttings always have the same kind of blossoms as the vine they were taken from.

A man once set a large garden full of strawberry plants, nearly all of which had pistils, or female organs only. He had plenty of blossoms, but no fruit. By putting a sufficient number of either perfect or staminate plants among them, he might have had fruit.

A lady once cut off the "false blossoms," staminate ones, from

her cucumber vines, to make them bear better. She should have known that these were just as necessary as the others. A botanist knows how to keep different varieties of corn, melons, etc., from intermixing and degenerating.

Last summer Dr. Wright, of Penn Yan, New York, wrote me that he had seen in a New York paper a statement that a grass or grasses in Kansas never produced seed. He did not believe it, but wished to know whether I knew of any such grass. I replied that every every plant in favorable circumstances produced seed, but if the soil, climate or season were unfavorable, and especially if the plant also produced tubers, it might seldom produce seed. From time immemorial (to me), my father had in his garden a dense thicket of artichokes, Helianthus tuberosus. They never blossomed till I cultivated some of them in hills like potatoes. Sweet potatoes seldom or never blossom in this climate, but doubtless they do in their native place. Some varieties of common potatoes seldom or never blossom; others blossom, but produce no seed; while others produce seed abundantly. I have noticed that those varieties which have "balls" have poor, watery potatoes.

A patch of wild rice in a wet basin near Osawatomie sent up no flower stalks for seven years, and then it had them twelve feet high.

The three most common and valuable prairie grasses of Kansas, some years produce only leaves, except in some favored spots.

Buffalo grass, so called in Miami county, seldom or never blossoms, but doubtless it does further west.

Some pear trees and plum trees blossom abundantly, but never bear fruit; probably from a lack of something in the soil that is needed to perfect the fruit.

Plants not in the Class-book nor Manual, are marked thus; * immigrants thus. †

ADDITIONS TO THE CATALOGUE OF THE PLANTS OF KANSAS FOR THE YEAR 1873.

RANUNCULACEÆ.

Clematis, Virgin's Bower.

C. Pitcheri. One specimen

Anemone, Wind Flower.

A. patens or Nuttalliana. Western Kansas. Snow.

Ranunculus, Crowfoot.

R. recurvatus. Lawrence and Leavenworth. Snow.

R. fascicularis. Wakarusa woods. Snow.

NYMPHÆACEÆ.

Nymphæa, White Water Lily.

N. odorata. Southern Kansas. Prof. Mudge.

FUMARIACEÆ.

Corydalis.

C. aurea, variety flavula. Lawrence. Snow.

C. montana. Lawrence, Snow. Topeka, Popenoe.

CRUCIFERÆ.

Nasturtium, Water-cress.

N. sylvestre. Lawrence, rare.

Dentaria, Pepper Root.

D. laciniata. Wakarusa.

Cardamine, Bitter Cress.

C. rhomboidea. Leavenworth. Wherrell.

Arabis, Rock-cress.

A. Canadensis. Vinland.

Brassica and Sinapis, Cabbage and Mustard.
†B. arvensis. Field Mustard. Snow.

Lepidium, Peppergrass.
*L. intermedium. Lawrence. Saunders.

Vesicaria, Bladder-pod.
*V. Fendleri. Ellis. Watson.

CAPPARIDACEÆ.

Cleome, Spider Flower.
*C. integrifolia. Leavenworth, T. E. Wilcox, U. S. A.; also Topeka, Popenoe.

VIOLACEÆ.

Viola, Violet.
V. sagittata. Lawrence, one specimen. Snow.

CARYOPHYLLACEÆ.

Agrostemma, Corn Cockle.
†A. Githago. Topeka. Popenoe.

Cerastium, Mouse-ear Chickweed.
C. nutans. Lawrence. Not abundant.

Arenaria, Sandwort.
*A. stricta. Ellis. Watson.

MALVACEÆ.

Callirrhoe, Mallow.
*C. involucrata. Salina; also Russell Co. Snow.

Malvastrum.
*M. coccineam. Abundant in Central and Western Kansas. Snow.

GERANIACEÆ.

Geranium; Crane's Bill.
G. maculatum. Leavenworth. Wherrell.

BALSAMINACEÆ.

Impatiens, Touch-me-not.
I. fulva. Topeka. Popenoe.

POLYGALACEÆ.

Polygala, Milkwort.
*P. alba. Ellis. Watson.

LEGUMINOSAE.

Vicia, Vetch.
*V. linearis. Common at Lawrence. Snow.

Lathyrus, Sweet Pea, etc.
*L. linearis. Ellis. Watson.
[Are these two the same?]

Trifolium, Clover.
T. procumbens. Yellow Clover. Topeka, Popenoe.
†T. arvense. Topeka, one specimen, Popenoe

Astragalus, Milk Vetch.
*A. multiflorus. Ellis. Watson.

Oxytropis.
*O. Lambertii. Western Kansas. Snow.

Glycyrrhiza, Licorice.
*G. lepidota. Lawrence. Also sent from Marshall county by W. J. McLaughlin. Abundant in alkali lands. Snow.

Hoffmanseggia.
*H. Jamesii. Western Kansas. Sent by Prof. Mudge.

ROSACEAE.

Pyrus, Apple, etc.
P. angustifolia. Lawrence. Snow. I think I found the same, but could hardly make it agree.

Rosa, Rose.
*R. ———. Lawrence. Referred to last year as a variety. Mr. Wood thinks it distinct. Stem strigous, 18 high; leaflets mostly 9; flowers corymbous, about 10; fruit mostly conical.

LYTHRACEAE.

Cuphea, Cuphea.
C. viscosissima. Near Osawatomie.

ONAGRACEAE.

Œnothera, Evening Primrose.
*Œ. lavendulæfolia. Ellis. Watson.

Gaura.
*G. virgata. Lawrence. Snow. Probably the same as G. linifolia given last year from Eaton.

Ludwigia, Bastard Loose-strife.
L. alternifolia. Leavenworth. Wherrell.
L. palustris. Lawrence. Saunders.

Myriophyllum, Water Milfoil.
M. scabratum. Lake four miles from Lawrence.

CACTACEAE.

Opuntia, Prickly Pear.
*O. vulgaris, var. Rafinesquii. Lawrence. Saunders.

SAXIFRAGACEAE.

Heuchera, Alum Root.
H. hispida. Lawrence. Snow. Also Leavenworth. Wherrell.

UMBELLIFERAE.

Cicuta, Water Hemlock.
C. maculata. Lawrence.

Cryptotænia, Honewort.
C. Canadensis. Lawrence. Snow.

Æthusa, Fool's Parsley.
Æ. cynapium. Lawrence. Snow.

COMPOSITAE.

Liatris.
L. cylindracea. Lawrence. Saunders.

Aster, Aster.
A. sagittifolius. Lawrence. Saunders.

Diplopappus, Double-bristled Aster.
*D. ericoides. Ellis. Watson.

Solidago, Goldenrod.
S. virgata. Miami county.
S. speciosa, var. rigidiuscula. Topeka. Popenoe.

Heterotheca.
H. scabra. Lawrence, one specimen. Snow.

Eclipta.
E. procumbens, erecta and alba, var. brachypod. Lawrence. Saunders.

Silphium, Rosin-weed.
S. laevigatum. Lawrence. Common.
*S. asperrimum. Lawrence. Snow.

Heliopsis, Ox-eye.
H. lævis. Type of which var. scabra is more common. Lawrence. Saunders.

Echinacea, Purple Cone-flower.
*E. atrorubens. Lawrence. Occasional.

Rudbeckia, Cone-flower.
R. triloba. Lawrence.
R. hirta. Lawrence. Snow.

Lepachis.
*L. pulcherrima, var. of columnaris. Lawrence. Saunders.

Helianthus, Sunflower.
H. tracheliifolius. Lawrence. Saunders.

Gutierrezia.
G. Euthamiæ? [T. and A.] Mr. Wood says: Genus certain, species doubtful — ray pappus uniformly wanting. He suggests the name G. heteropappus. Roadsides. Eudora and Paola. Fifteen inches high, branching above; flowers bright yellow.

Cirsium, Thistle.
C. Virginianum. Lawrence. Saunders.

Krigia, Dwarf Dandelion.
K. Virginica. Lawrence, one specimen, Snow

Hieracium, Hawkweed.
H. Gronovii. Lawrence. Snow.
H. paniculatum. Lawrence. Snow.

LOBELIACEAE.

Lobelia, Lobelia.
L. spicata. Topeka, rare. Popenoe.

CAMPANULACEAE.

Specularia.
*S. leptocarpa. Lawrence, one specimen. Snow.

PLANTAGINACEAE.

Plantago, Plantain.
P. lanceolata. Lawrence, one place; also Topeka, Popenoe.

OROBANCHACEAE.

Conopholis [Wallroth]; Philipea [Don.] Squaw Root.
C. Ludoviciana. From W. J. McLaughlin, Marshall county. Snow.

SCROPHULARIACEAE.

Linaria, Toad-flax.
*L. vulgaris. Roadside, Lawrence.

Pentstemon, Beard-tongue.
P. grandiflorus. Russell county, abundant. Snow. Also Lawrence. Saunders.
P. pubescens. Various places. The P. Digitalis of last year.

Conobea.
C. multifida. Osawatomie. Also Lawrence. Snow.

Veronica, Speedwell.
V. Anagallis. One place seven miles southwest of Lawrence.

Castilleja, Painted Cup.
*C. pallida. Ellis. Watson.

LABIATAE.

Scutellaria, Skullcap.
*S. Drummondii. Lawrence, rare. Snow.
S. lateriflora. Sent from Marshall county by S. D. Mauk. Snow.

Stachys, Hedge Nettle.
S. palustris. One place five miles east of Lawrence.
S. sylvatica. Lawrence, one specimen, Snow.
[S. sylvatica, Nutt., S. Nuttalliana, Shuttlew.]

BORAGINACEAE.

Echinospermum, Bur-seed.
*E. Redowskii. Ellis. Watson.

CONVOLVULACEAE.

Cuscuta, Dodder.
C. tenuiflora. Lawrence. Saunders.
C. Gronovii. Lawrence, common. Snow.

ASCLEPIADACEAE.

Asclepias, Milkweed.
A. Sullivantii. Wakarusa bottom. More social than other species.
A. Vaseyi. One place.
*A. ———. Lawrence. Several specimens. Mr. Wood cannot find its name. Stem slender, 2″ diam., 15′ high, pubescent; leaves opposite, lanceolate, sessile, round at base, acute at apex; 2′ long, 10″ wide; umbel one, terminal, nodding peduncle 1′-2′.

ARISTOLOCHIACEAE.

Asarum, Wild Ginger.
A. Virginicum. Lawrence, Woods.

POLYGONACEAE.

Polygonum, Knot Grass, etc.
P. maritimum. Lawrence. Occasional.

CHENOPODIACEAE.

Cycloloma.
*? C. ———. A specimen was on exhibition at the state fair from southwestern Kansas, 2½ ft. broad, and 15 inches high, with a short stem one or two inches in diameter. The leaves had fallen off; the fruit was smaller than on specimens found here.

EUPHORBIACEAE.

Acalypha, Three-seeded Mercury.
A. gracilis. Lawrence. Saunders. A. gracilens, Gr. same as A. Virginica, E.?

URTICACEAE.

Parietaria, Pellitory.
P. Pennsylvanica. Lawrence.

JUGLANDACEAE.

Juglans, Walnut.
J. cinerea, Butternut. Lyon Co. Popenoe.

Carya, Hickory.
C. aquatica. Common. Known by leaflets resembling peach leaves.
C. microcarpa. Near Osawatomie. The bark is nearly black.

C. ———. Little trees found near Clinton. Leaflets about 9, closely sessile, obovate-lanceolate, and strongly cordate at base. If this is the C. amara, this point should be noticed.

CUPULIFERAE.

Quercus, Oak.

Q. falcata, Spanish Oak. Lawrence and Willow Springs.

SAURURACEÆ.

Saururus, Lizard-tail.

S. cernuus. Lawrence, one specimen. Snow.

NAIADACEÆ.

Najas, Water Nymph.

N. flexilis. Lake four miles north Lawrence.

Potamogeton, Pond-weed.

P. natans. Lake. The one foretold last year.
P. pectinatus. Lake. All three abundant.

ALISMACEÆ.

Sagittaria, Arrow-head.

S. variabilis, var. gracilis, leaves narrow, same lake. Also var. obtusifolia and sagittæfolia, very common, distinguished by Dr. Saunders.

Echinodorus.

E. rostratus. Lake, abundant. Snow.

HYDROCHARIDACEÆ.

Anacharis, Ditch Moss.

A. Canadensis. Lawrence. Saunders.

AMARYLLIDACEAE.

Hypoxis, Star-grass.

H. filifolia. Topeka. Popenoe.

SMILACEÆ.

Smilax, Greenbrier.

S. tamnifolia. Lawrence. Snow.

LILIACEÆ.

Allium, Onion.

*A. reticulatum. (?) Ellis. Watson.

PONTEDERIACEAE

Heteranthera.

H. reniformis. Lawrence. Saunders.

JUNCACEAE.

Juncus, Rush.

J. tenuis. Lawrence; very common.
J. megacephalus, or J. nodosus, var. megacephalus. Lawrence. Common.
J. scirpoides, var. echinatus. Lawrence.

CYPERACEAE.

My cyperaceæ were mostly examined by Dr. S. H. Wright, of Penn Yan, N. Y. Prof. Snow's are undoubtedly correct.

Cyperus, Galingale.

C. phymatodes. Lawrence.
C. Michauxianus. Lawrence. Saunders.
C. inflexus. Lawrence.
C. inflexus, var. thrice longer. Lawrence.
C. acuminatus. Lawrence.
C. compressus. Lawrence.

Eleocharis, Spiked Rush.

E. palustris. Lawrence.
E. tricostata. Near Eudora.
E. olivacea. Lake.
E. tenuis. Lawrence.

Scirpus, Bulrush.

S. debilis. Lawrence.
S. fluviatilis. Water.
S. polyphyllus. Lawrence, common. Snow.
S. lineatus. Lawrence.

Fimbristylis.

F. spadicea. Lawrence.

Trichelostylis.

T. autumnalis? Lawrence.
T. capillaris? Lawrence.

Carex. Sedge.

I give the names in Wood's Botanist and Florist, and in the order of that book. Where the names given me were different, I give both names.

C. vulpinoidea. Lawrence.
C. stipata. Leavenworth. Wherrell.
C. cephalophora. Lawrence.
C. rosea. Leavenworth. Wherrell.
C. scoparia. Lawrence.
C. cristata. Lawrence.
C. straminea. Lawrence.
C. festucacea. Lawrence. Snow.
C. adusta. Lawrence.
C. stricta. (acuta.) Lawrence. Snow.
C. Davisii. Lawrence.
C. stenolepis. Lawrence. Snow.
C. laxiflora. Lawrence. Snow.
C. granularis. Lawrence.
C. panicea. Lawrence.
C. Meadii. Very common in Eastern Kansas. Snow.
C. Hitchcockiana. Leavenworth. Wherrell.
C. lanuginosa (pellita.) Lawrence. Snow.
C. polymorpha. Lawrence. Snow.
C. riparia (lacustris.) Lawrence. Snow.
C. ampullacea (utriculata.) Lawrence. Saunders.

GRAMINEAE — GRASSES.

The gramineæ given below were all found near Lawrence, except as otherwise given:

Leersia, False Rice.

L. oryzoides, Cut Grass.

Agrostis, Bent Grass.

A. vulgaris, Red Top.
A. alba, White Bent, Bonnet Grass.
A. elata, Taller Thin Grass.

Sporobolus, Drop-seed Grass.

S. cryptandrus.

Cinna, Sweet Reed Grass.

C. arundinacea. River bank near Osawatomie

Muhlenbergia, Drop-seed Grass.

M. glomerata.

M. diffusa. Alongside walks and in shady places covering the ground. Leaves very short and nearly at right angles with the stem.

*M. ———. River bank, Osawatomie. Mr. Wood cannot find the same. He thus describes it: "Slender, glabrous, branching, one foot high; panicle erect, capillary, loose, branches in 3's and 5's, whorled. Spikelets scarcely 1" long, much shorter than their pedicels. *Glumes pointed, rough on the keel, the upper one shorter, but longer than the two equal obtuse 3-veined pales*, which have a few short beards at their base. Comes nearest to M. Mexicana, but is decidedly different by the characters italicized."

Calamagrostis, Reed Bent-grass.

C. Canadensis, Blue Joint. One place, Wakarusa bottom.

Paspalum.

P. fluitans. Mostly under water. Osawatomie.

Panicum, Panic Grass.

P. proliferum.
P. agrostoides.
P. viscidum. Snow and Saunders.

Bromus, Brome Grass.

B. secalinus, Chess.
B. mollis, Downy Chess.
B. ciliatus.

Tricuspis.

T. (Uralepis) purpurea.

Dactylis, Orchard Grass.

D. glomerata.

Festuca, Fescue Grass.

F. ovina, Sheep's Fescue.
F. pratensis, Meadow Fescue.
F. elatior.

Eatonia.

E. obtusata.

Melica, Melic Grass.

M. mutica. Scattered, tall, conspicuous.

Eragostis.

E. reptans. Riverbank, Osawatomie.
E. purshii.
E. erythrogona. Seen once.

Poa, Spear Grass.

P. compressa.
P. sylvestris. Both have flattened stems.

Glyceria, Manna Grass.

G. nervata.
G. maritima.

Triticum, Wheat.

T. violaceum. Distinct from T. repens or or Couch Grass.

Leptochloa.

L. mucronata. Osawatomie.

Eleusine, Yard Grass.

E. Indica. Yard of Presbyterian church, Lawrence.

Buchloe, Buffalo Grass.

*B. dactyloides. Ellis. Watson.

A grass called by this name grows near Osawatomie, but it seldom or never blossoms, so that it would require close observation to determine it. It grows in stools as Buffalo grass is said to, and is of about the same size.

Filices, Ferns.

Polypodium. Polypody.

P. incanum. Burlington. Mrs. J. N. Locke.

Aspidium, Shield Fern.

A. spinulosum, var. Boottii. Lawrence. Saunders.

HEPATICAE.

Marchantia.

*M. polymorpha. Saunders.

Species added, about 175.

Not east of Mississippi, about 27.

LAWRENCE, KANSAS, Dec., 1873.

SPECULATIONS IN REGARD TO COMETS' TAILS.

BY F. W. BARDWELL.

Of all questions in Astronomy pressed conspicuously upon notice, none seem to elude the grasp of the scientist with more subtlety than that of the character and composition of comets' tails. From Copernicus to Newton, from Newton to Le Verrier and to the spectroscopist of to-day, are seen a series of brilliant triumphs. The Ptolemaic epicycles have vanished into the simplest of curves; the multitudinous array of celestial orbs follow each other with infinite precision and never-ending succession, according to laws comprehensible

almost by a child. The perturbations of Uranus have responded to the interrogations of Le Verrier and Adams, and our sun and the more distant suns, though they tarry not in their courses at the command of any modern Joshua, yet reveal to the searching gaze of the spectroscopist the secrets of innumerable ages, and declare their common membership of one illimitable system.

Such are the conquests of astronomers; and yet an intruder, as it were, rushes impetuously into the insignificant domain of our own solar system, and, it may be, with a passing nod to Jupiter, whirls angrily around the sun, whose proximity seems to kindle a fiery train, then retreats as suddenly as he appeared, departing with regal courtesy, never turning the back toward the gaze of his august majesty, the Sun, and at his disappearance leaves the ignorant beholder terrified, and the startled philosopher bewildered.

Let us glance briefly at the more important facts, and try to find out their significance. Comets are those bodies moving around our sun in orbits of considerable eccentricities. Perhaps this characteristic is the most decisive of those which serve to distinguish them from other members of our solar system, though the classification may really be empirical. There is, indeed, great diversity in the phenomena attending different comets. Some accomplish their revolutions in three or four years; others in three or four thousand years; others still in a hundred thousand years; and finally, it is thought some never revisit our solar system. Many comets have tails, so called, while others have none; and still others are surrounded by envelopes of a hazy or misty appearance. Some of the so-called tails have been of remarkable extent, and in general have followed the comets in approaching the sun, and preceded them in going away, attaining their maximum soon after passing perihelion. This it is that has so puzzled astronomers. The nucleus evidently obeys the law of gravity, but in passing perihelion the tail sweeps around contrary to that law, and with a vivacious energy that would laugh gravity to scorn.

It has been suggested that the matter composing the comets' tails differs essentially from that of the nucleus, being of a nebulous character, or at any rate in a nebulous condition; though the exact nature of this character or condition of matter no one could define, but it was thought to be misty-like, or vaporous and extremely rarefied. It was further thought that some repulsive force, emanating in the sun, acted on the nebulous fog of the tail, while it did not act on the nucleus, thus giving to the sun a double-dealing character, blowing hot and blowing cold at the same time, quite at variance

with his usual character for consistency. Bessel computed the form and motion of the comets' tails subject to such a repulsive force in the sun; and after him, Pierce. Bessel supposed that the material elements of the tail were developed from the nucleus, flowing away from it and soon lost to it; that is, became separated from it so far that the attraction of the nucleus no longer had an appreciable effect upon them, while the repulsive force of the sun carried them off still further and dissipated them entirely from view. But this hypothesis involves the difficulty of supposing that the same matter which originally formed a part of the nucleus, and as such moved subject to the attractive force of the sun, afterwards becoming evolved from the nucleus, was then repelled by the force of the same sun with an increased energy.

Now a change in the molecular condition of the elements of a body may often develop repulsion among those elements, as for instance, the ignition of powder or even an increase of temperature, and so we may understand the development of a repelling force whose center is situated within the nucleus; but in Bessel's hypothesis the center of the repellant force is supposed to be in the sun, millions of miles away.

Though Bessel's hypothesis may have given way in the light of more recent investigations, yet a statement of it in this place may help to present in a clearer light the real difficulties in the problem before us. And in looking for all the facts that may have a bearing on the question, let us not forget that the space between the sun and planets, and even that between our solar system and other systems, cannot be absolutely void, for light, whether it come from our sun as the bright harbinger of day, or whether it come in the faint twinkling that reaches us after a tireless flight of centuries, in either case travels along the waves of celestial ether of unbroken continuity. Where the terrestrial atmosphere fades away, or at what limits the solar atmosphere loses itself in the ethereal depths, we know not; yet it has been clearly established that flames of meteors become visible in the neighborhood of the earth at a greater distance from the earth than the supposed limits of our atmosphere, these flames apparently resulting from the resistance of the medium through which the meteors pass; and the zodiacal light, evidently a solar phenomenon, indicates the existence of a belt of luminous matter, or of matter that may become luminous, extending around the sun, even outside the earth's orbit.

Next in order may be mentioned the interesting relation recently shown to exist between some of the comets and periodic meteors

Thus, Tempel's comet of 1865, and the November meteors, are said to have the same orbit; that is to say, the orbits are so nearly identical that they indicate a common origin. In a similar way it is found Tuttle's comet of 1862 moves along in company with the August meteors, and the bright comet of 1861 moves in company with a less conspicuous group of April shower-meteors.

Oppolzer, Peters, Weisse, Le Verrier and others have contributed to these results; but Schiapparelli, of Milan, has been the most active, both in obtaining results and interpreting them, and his theory is favorably received. Nebulæ is a name given to bodies of cosmical matter in that diffuse condition in which it is supposed the material of the solar system once existed, when it occupied continuously all the space from its center far beyond the limits of Neptune's orbit. Schiapparelli supposes that among such cosmical clouds, floating in space, it occasionally happens that one comes within reach of the sun's attractive influence. The attraction acts more powerfully on the nearer portion, and while the nebula is still at a great distance, it begins to lose its spherical form, becomes elongated and somewhat cylindrical, the foremost part becoming denser and more pointed. As it approaches nearer the sun the transformation becomes more complete, the part nearest the sun becoming a dense nucleus, and the part following forms the tail, curved in consequence of the lateral motion preserved by the nebula during its progress.

Thus we have a comet moving in an orbit whose eccentricity and plane depend upon the initial circumstances. The comet is not, however, a solid mass, but consists of particles, each possessing an independent motion, and the comet becomes more elongated, and at last is resolved into a ring of meteors. In the course of time the matter composing a comet, which completes its revolutions around the sun, must be dispersed over the whole path. Schiapparelli affirms that the comet of 1862, No. III, is simply the remains of the original comet, out of which the meteoric ring of the 10th of August has been formed in the course of time. Le Verrier, adopting the this theory, traces the history of the comet of 1866, No. I, first discovered by Tempel. A cosmical nebulous cloud he thinks entered our system in January, 126, and happening to pass near the planet Uranus was brought by its attraction into an elliptic orbit around the sun. This orbit is that of Tempel's comet, and identical with that of the group of November meteors. He supposes this meteoric cloud became visible as a comet in 1866 for the first time. The tail of this comet is composed of the multitude of small meteoric

bodies which follow the nucleus, and as our earth encounters them for three successive years, the tail must have a length of nearly eighteen hundred millions of miles. Such, in brief, is the theory of comets and their tails, as advocated by Schiapparelli and Le Verrier, but it seems to leave the original difficulties, with no diminution of their force.

This theory seems to offer no satisfactory explanation of the mode by which the material elements of the tail are seen first to follow the nucleus ; then, near perihelion, to be chiefly outside the orbit ; and finally, to be in advance of the nucleus. Spectrum analysis has in a wonderful manner enabled astronomers to penetrate long-hidden secrets ; and naturally, this agent has been summoned to aid in the solution of this question. So far, however, the opportunities to make this agent available in the examination of comets have been limited. Donati was the first, in 1864, to study spectroscopically the light of comets ; and recently Secchi, Huggins, and others have given their attention to the same object. No brilliant comet has in the meantime appeared ; and the results obtained, which chiefly pertain to the nucleus only, though of importance, may be briefly stated. It seems then clearly established by spectrum analysis, that the nucleus of a comet is self-luminous, and that the luminous portion is glowing gas — in some instances carbon being present. It is also probable that the luminous nucleus may in a slight degree reflect sunlight. Scarcely more than this has yet been determined by means of the spectroscope; but the appearance of any bright comet will be the occasion of the most attentive observations, and we may hope then for a complete solution of this interesting puzzle.

In the meanwhile, waiting thus for the return of such a far-wandering messenger, even now on the way laden with news, we can only indulge in speculations; and I venture to offer some of these that point, it may be, toward a solution —speculations that may subsequently be verified, or subsequently prove to be fallacious.

Allusion has already been made to the zodiacal light, which indicates the existence of a belt of luminous matter, or of matter that may become luminous, extending far out from the sun. The motions of Encke's comet indicate a resisting medium, and let us suppose this granted. In accordance with this hypothesis, observation shows that for the same comet the display of a brighter train occurs, with an increased velocity and diminished distance from the sun, the cumulative effects of which reach a maximum only after perihelion passage. For different comets, so far as other conditions coincide, the same principle is verified.

We have seen, too, that comets and meteors appear in some instances to have a common origin, and that meteors are composed chiefly of elements well known, though it is probable that the more volatile elements become entirely separated in passing through our atmosphere from the more solid portion which actually reaches the surface of the earth.

Let us suppose, then, that we have merely a larger mass of meteoric matter, possessing in its composition some elements capable of volatilization, moving in such an orbit as any of the comets are observed to have; then, with the exception of the tail, all the phenomena of a comet would naturally follow, according to the different circumstances supposed. Entering the resisting medium more or less heat would be developed, according to the velocity, which would increase as the mass approaches the perihelion, while the resistance and heat would increase still more rapidly, attaining a maximum soon after passing that point. The heat thus developed and probably increased by the proximity of the sun, would tend to volatilize some of the elements of the body, causing them to become luminous and present the phenomena of the corona and the nucleus. It is possible, too, that some of the elements of the medium through which the body is moving would share in and increase the luminosity.

Now, with regard to the tail, it has been heretofore assumed that the train so designated, often accompanying a comet, is an essential part of it. Bessel thought, as we have seen, that the material elements of the tail were derived from the nucleus flowing from it, and then repelled by a force centered in the sun. Schiapparelli and Le Verrier think these elements are of the same kind of substance as that of the nucleus, but in a more diffuse condition, and becoming luminous by some motion among themselves.

But may it not be possible that this train of light which accompanies a comet, and has been called a tail, is in fact, no part of the comet more than a shadow is a part of the object which gives it form? May it not consist of particles of the medium through which the comet passes, made luminous by the rays of the sunlight acted on by the glowing gas of the corona? If the zodiacal belt forms this medium, in whole or in part, being already slightly luminous, its luminosity (it is possible to imagine) might be easily increased.

How the phenomenon of light is actually produced, we do not know. We know that the flames of certain gases give rise to it—that is, cause the necessary undulation of the ether, and we know that our sun is the source of a large supply of light, and, though we

may know some of the attendant circumstances in these cases, yet who can tell the circumstances that give rise to auroral light, or who can tell the origin of zodiacal light?

So we may see the phenomenon of light in the train that accompanies the comet, and, though we may not be sure of all the conditions that take place, yet it seems highly improbable that this luminous mist forms any part of the comet, and I predict that when a brilliant comet gives an opportunity to apply the tests of spectrum analysis, it will appear that this bright train is not nebulous, as Bessel thought, and is not diffuse meteoric matter, as Schiapparelli and Le Verrier have supposed, but is the illumination of the medium through which the comet is passing.

In closing, let us notice several facts that have interest in this connection:

It was thought highly probable that the earth passed through a portion of the tail of the bright comet of 1861, on the 30th of June, of that year. The effect was apparently to dim slightly the light of the sun before sunset, and at the same time to give the sky an "auroral, glare-like look." The comet itself, in the evening, had a more hazy appearance than at any other time after that evening. These incidents seem inconsistent with the theory of a meteoric composition of the tail, but more consistent with the hypothesis of a luminous shadow formed by but not a part of the comet. In 1807 and again in 1811, Chladni, a careful observer, noticed what he styled a prodigious ebullition proceeding from the nucleus to the extremity of the tail of a comet, in a few seconds of time. The tail of the comet of 1811 was estimated to extend four millions of leagues, and light itself travels no faster. It was as if the waves of ether were made visible in their undulations.

A few words with regard to the resistance of a medium, and I close. Only the orbits of short-period comets have been determined with any approach to accuracy; and of these, Encke's has the least perihelion distance. This comet, too, has a shortening of its period, apparently in consequence of the resistance of the medium through which it passes. Is it not probable, too, that such a resistance is the explanation of some of the irregularities of the comets of long period? Thus the comet of 1264 and 1556 was expected to return in 1848. May it not be that the comet of 1843 was the identical one with its period shortened? The comet of 1843 passed very near the sun; nearer even than Encke's comet. Arago made a study of the records of Halley's comet, to determine if possible whether in its successive reappearances it had lost any of its brilliancy. He

thought it had lost nothing. May not this again be due to the probable fact that in successive returns the comet approaches nearer the sun, encounters more and more of the resistance of the medium, and therefore tends to develop more fully the phenomena of the tail, which would otherwise be less developed, because the nucleus must be losing some of its volatile elements?

Thus questions of interest press upon us, and astronomy, though the oldest of the sciences, is ever opening new and attractive fields of study.

METEOROLOGICAL SUMMARY FOR THE YEAR 1873.

PROF. F. H. SNOW'S ANNUAL REPORT AS METEOROLOGIST TO THE STATE BOARD OF AGRICULTURE.

Station, Lawrence. Kansas. Latitude 38°, 58′; longitude 95°, 16′. Elevation of barometer and thermometers, 884 feet above the sea level and 14 feet above the ground; rain gauge on the ground; anemometer 105 feet above the ground, on the dome of the University building.

TEMPERATURE.

Mean temperature of the year 52.71°, which is 0.17° lower than the mean temperature of the five preceding years. Notwithstanding this very near approximation of the mean yearly temperature to the mean of past years, the range of temperature was much greater than in any previous year of our record, amounting to 130°. The extremes were 26° below zero January 29, and 104° above zero August 29 and 30. These extremes were respectively 8° lower and 1° higher than any indications of former years. Mean temperature at 7 A. M., 46.15°; at 2 P. M., 61.80°; at 9 P. M., 50.18°.

Mean temperature of the winter months, 26.75° (2.46° below the average); of the spring, 52.10° (1.62° below the average); of the summer, 78.06° (2° above the average); of the autumn, 53.37° (1.28 above the average).

The coldest month of the year, also the coldest month on our record, was January, with mean temperature 18.61°; the coldest week was January 23-29, mean temperature only 2.60° above zero; the coldest day was January 28, with mean temperature 13° below zero. The night of January 28–29 was excessively cold, the mean of seven observations taken at intervals during the night being 22.5° below zero.

The hottest month of the year was August, with mean temperature 79.38°; the hottest week was August 25–31, mean temperature 86.34°; the hottest day was August 30, mean temperature 89.3°.

The mercury fell below zero on nine days—January 9, 10, 17, 18, 24, 28, 29, and February 1 and 2.

There were 48 days on which the mercury reached or exceeded 90°, viz.: 9 in June, 12 in July, 24 in August, and 3 in September. The mercury reached or exceeded 100° on 10 days, all of which were in August. Seven of these days were consecutive, the last seven days of the month; this continuation of intense heat being unprecedented since the record began.

The last frost of spring was April 25, this being a severe frost. The first light frost of autumn was September 8, giving a period of 136 days entirely without frost. The first severe frost of autumn was delayed until October 23, making the period of absence from severe frost 181 days. The excessive cold of the winter killed nearly every peach bud in Douglas county and a large proportion of peach trees over four or five years old. The severe frost of April 25 killed some pear, cherry and plum buds which were just coming into blossom, but left enough buds uninjured to secure an abundant crop.

RAIN.

The entire amount of rain, including melted snow, was 32.94 inches, which exceeds the rainfall of 1872 by 0.31 inch, but is less than the average rainfall of the five preceding years by 1.69 inches. Either rain or snow fell on 101 days—two less than the average number. The longest interval without rain during the growing season, March 1 to October 1, was 12 days, from July 18 to 29. The number of thunder showers was only 17; in 1872 there were 40. There was a marked peculiarity in the distribution of rain this year, giving a great excess to April, May and December, and a great deficiency to July and August. This irregularity of distribution resulted in an exceptionally abundant harvest of wheat and early potatoes, and a light yield of corn and late potatoes.

SNOW.

The entire depth of snow was 26½ inches, distributed as follows: January, 16 inches; February, 3 inches; March, 2 inches; April, 2 inches; December, 3½ inches. The last snow of spring was April 15; the first autumn snow was on October 27, not enough in the the latter case to whiten the ground. The annual amount of snow, as given above, is 4.90 inches above the average for the five preceding years.

FACE OF THE SKY.

Average cloudiness of the year, 42.46 per cent. of the sky, which is 3.77 per cent. less than the average. The number of clear days (less than one-third cloudy) was 173; half-clear days (between one-third and two-thirds cloudy), 91; cloudy days, 101. There were 37 days without a cloud, and 29 days without a trace of sky, 10 of the latter being in December. There was not one entirely cloudy day from May 15 to November 1. August was the clearest month — mean cloudiness, 23.87 per cent.; December was the cloudiest month, the me n being 61.50 per cent. The mean cloudiness at 7 A. M. was 47.15 per cent.; at 2 P. M. 46.47 per cent.; at 9 P. M., 33.75 per cent.

DIRECTION OF WIND.

During the year (three observations daily), the wind was from the northwest 261 times; southwest, 218 times; south, 153 times; southeast, 142 times; northeast, 105 times; north, 88 times; east, 72 times; west, 35 times; calm, 21 times. The south winds (including southeast, south and southwest) outnumbered the north winds (including northeast, north and northwest) in the ratio of 513 to 454.

VELOCITY OF WIND.

The number of miles traveled by the wind was 154,508. This gives a mean daily velocity of 423.31 miles and a mean hourly velocity of 17.63 miles, the latter being 6.63 miles above the mean hourly velocity at Philadelphia. The position of the anemometer cups at an elevation of 105 feet above the ground, the most elevated point for full fifty miles in all directions, secures exposure to the full force of the wind. The maximum velocity was attained June 27, when in 22½ minutes the instrument registered 31½ miles, or at the rate of 85 miles an hour. The greatest daily velocity was 1,502 miles, November 18. The strongest winds were in March, April and November; the lightest were in July and August.

BAROMETER.

Mean height of barometer column, 29.093 inches. Mean at 7 A. M., 29.114 inches; at 2 P. M., 29.071 inches; at 9 P. M., 29.093 inches. Maximum height, 29.727 inches, at 2 P. M., February 1; minimum, 28.533 inches, at 9 P. M., April 3; yearly range, 1.194 inches. The highest monthly mean was in December, 29.199 inches; the lowest was in May, 28.947 inches. The barometer observations are corrected for temperature, but not for elevation, in accordance with the rules of the Smithsonian Institution.

RELATIVE HUMIDITY.

Mean for the year, 64.06; at 7 A. M., 75.14; at 2 P. M., 45.77; at 9 P. M., 71.28. The dampest month was December, humidity 76.38; the driest month was March, humidity 52.88. On the 28th, 29th and 30th of March the air was exceedingly dry, the percentage of moisture at 2 P. M. on the latter date sinking to 3.8, or less than one twenty-fifth of the amount required for saturation. There were only six fogs during the year.

FORCE OF VAPOR (IN INCHES.)

Mean for the year 0.308; at 7 A. M., 0.302; at 2 P. M., 0.300; at 9 P. M., 0.321; greatest, 0.983 at 2 P. M., July 5; least, 0.012 at 7 A. M. January 29; highest monthly mean in June, 0.619; lowest in January, 0.091.

The following table gives the mean temperature, the extremes of temperature, relative humidity, and rainfall for each month of the year 1873; also a comparison with preceding years:

Month.	Mean Temperature.	Max'm Temperature.	Min'm Temperature.	Relative Humidity.	Rainfall in Inches.
January	18.61	46.5	—26.0	75.57	2.66
February	30.26	62.0	—6.5	68.15	0.86
March	42.81	74.0	4.0	52.88	1.34
April	48.85	88.0	26.0	63.44	4.42
May	64.64	88.5	46.0	68.93	7.12
June	76.90	97.0	58.0	68.04	2.96
July	77.90	97.0	62.5	64.36	2.38
August	79.38	104.0	56.0	57.87	0.90
September	66.25	94.0	36 0	59.96	3.75
October	51.23	83.0	16.5	57.83	0.92
November	42.58	78.0	12.0	55.40	1.24
December	31.37	67.5	9.0	76.38	4.39
Year 1873	52.71	104.0	—26.0	64.06	32.94
Year 1872	51.90	97.0	—18.0	64.40	32.63
Year 1871	54.30	103.0	—6.0	.....	33.23
Year 1870	54.50	102.0	—10.0	68.40	31.38
Year 1869	50.36	96.0	—5.0	.....	38.51
Year 1868	53.36	101.0	—16.5	.....	37.42

TRANSACTIONS

OF THE

SEVENTH ANNUAL MEETING

OF THE

Kansas Academy of Science

(1874)

WITH REPORTS OF THE SECRETARY.

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1896.

REPORT OF THE KANSAS ACADEMY OF SCIENCE.

The Kansas Academy of Science was made a co-ordinate branch of the State Board of Agriculture by the laws of 1873.

Nearly all of the members of the Society have contributed something in the interests of science.

Prof. B. F. Mudge, who has been collecting for Prof. Marsh, of Yale, has found many new and rare specimens, which have not yet been determined.

Prof. J. H. Carruth has added to his catalogue of plants. He has been greatly assisted by Lieut. Wilcox of Fort Leavenworth, Miss Wright of Irving, Mr. Watson of Ellis, Mr. Popenoe, and others, who have contributed many new and important specimens.

Prof. Frank H. Snow, of the State University, has continued his observations on the "Birds of Kansas;" and Mr. E. A. Popenoe presents for the first time a list of the Coleoptera of Kansas.

PROCEEDINGS OF THE SOCIETY.

The seventh annual meeting of the Society was held in the House of Representatives, at Topeka, on October 5th and 6th. The attendance was larger, and the interest greater than at any previous meeting.

Among the transactions of the Society the following are of public interest:

A committee, consisting of A. Gray, B. F. Mudge, and E. A. Popenoe, were appointed "to secure such a modification of the game laws of Kansas, as shall allow the killing of any birds at any time by authorized parties for scientific purposes."

Prof. Frank H. Snow was appointed to make a report on the ravages and extent of the locust, its means of extermination, together with any other information which may be considered of value to the citizens of the State.

The following papers were read:

Brachiospongia, by Prof. W. C. Hovey.

Tin and Tin Salts, by Prof. W. K. Kedzie.

Elementary Sounds of the English Language, by Prof. J. H. Carruth.

On the Priestly Centennial, by Prof. W. K. Kedzie.

Catalogue of the Lepidoptera of Kansas (continued from last year), by Prof. Frank H. Snow.

The Pliocene Formation of Kansas, by Prof. B. F. Mudge.

Artificial Organic Compounds, by Miss Jennie M. Detmers.

The Water supply of Kansas, by W. Tweeddale.

Additions to the Catalogue of Kansas Birds, with remarks on the fertility of the Hybrid Woodpecker (Colaptes hybridus), by Prof. Frank H. Snow.

New and Rare Forms of Fossil Fish from Kansas, by Prof. B. F. Mudge.

Analysis of Clays from different parts of Kansas, by Dr. Wm. H. Saunders.

Additions to the Catalogue of Kansas Plants (continued from last year), by Prof. J. H. Carruth.

Notes from the Zoological Laboratory of the University of Kansas, by Prof. F. H. Snow.

A Mad Stone in Kansas City, by John D. Parker.

A Preliminary List of the Coleoptera of Kansas, by Edwin A. Popenoe.

Observations on the use of the Antennæ of Polyphylla variolosa (Harris), by Prof. F. H. Snow.

The Study of Natural History as a Disciplinary Power, by Prof. W. Wheeler.

The Importance of a Geological Survey of Kansas, by Prof. B. F. Mudge.

Geological Features of the Lower Neosho Valley in Kansas, by W. S. Newlon.

On Determining the Solubilities of Metallic Salts, by Prof. G. E. Patrick.

Disappearance of the Prairie Dog from Kansas, by Prof. B. F. Mudge.

Suggestions on the True Theory of Number, by Prof. F. W. Bardwell.

OFFICERS.

The following officers were elected for the current year:

President—Frank H. Snow, Lawrence.

Vice-Presidents—B. F. Mudge, Manhattan; John D. Parker, Wyandotte.

Secretary—John Wherrell, Leavenworth.

Treasurer—Robert J. Brown, Leavenworth.

Curators—Frank H. Snow, Lawrence; Edwin A. Popenoe, Topeka; W. K. Kedzie, Manhattan.

COMMISSIONS.

Geology — H. C. Hovey, Kansas City; B. F. Mudge, Manhattan.

Entomology — Frank H. Snow, Lawrence; Edwin A. Popenoe, Topeka.

Language — D. H. Robinson, Lawrence; J. H. Lee, Manhattan.

Ethnology — H. B. Norton, Emporia.

Engineering — F. W. Bardwell, Lawrence.

Meteorology — John D. Parker, Wyandotte.

Botany — J. H. Carruth, Lawrence; John Wherrell, Leavenworth.

Mineralogy — W. K. Kedzie, Manhattan.

Chemistry — G. E. Patrick, Lawrence.

Mammalia — M. V. B. Knox, Baldwin City.

The Society adjourned to meet at Topeka — the time of meeting to announce.

SUGGESTIONS OF THE TRUE THEORY OF NUMBER.

BY F. W. BARDWELL.

No one will question the importance of a correct theory of number, though many may be surprised at the suggestion that the current theories are imperfect in any important feature.

It is however true that there is a widespread dissatisfaction with the books which treat of the elements of number; that there are frequent changes in the text-books used in the schools; and that

educators, and the friends of education, often complain of the small results of the great amount of time and effort expended in the department of mathematics, and especially given to arithmetic.

These facts justify at least an inquiry in regard to the fundamental theory of number on which methods of instruction properly rest.

WHAT, THEN, IS NUMBER?

If, as some allege, no formal and perfect definition can be given, yet by means of careful study we should be able to talk intelligently about it, and be able to say confidently, *"this" is number, or "that" is not number.*

Mill says in his System of Logic: "The fact asserted in the definition of number is a physical fact. Each of the numbers two, three, four, etc., denotes physical phenomena and connotes a physical property of those phenomena. Two, for instance, denotes all pairs of things, twelve all dozens of things, connoting what makes them pairs or dozens; and that which makes them so is something physical, since it cannot be denied that two apples are physically distinguishable from three apples, two horses from one horse, and so forth; that they are a different, visible, and tangible phenomena."

NUMBER USED TO DESIGNATE HOW MANY.

Perhaps it will be admitted that one of the first and most obvious uses of number is to distinguish or define *how many* things are thought of. It may or may not be in answer to a question. In either case, the term called *number*, completely fulfills the function of telling *how many*.

Does number do anything more than tell how many? It appears not. If not, let number be defined as *that which expresses how many things are thought of*, and let this definition be accepted until some defect be found, or until some better definition be invented.

TWO CLASSES OF NUMBERS.

If there be a group of oranges, consisting of three whole ones and a half of one, that is, one of two equal parts of a whole one, then to describe how many are in this group one would say *three-and-a-half*, and this term obviously performs the same kind of office which in other instances is performed by the term *three*, or by *four*; in other words, it completely fulfills the office of number, and should be included under the name. The same may evidently be affirmed of *one-half* or *three-fourths*. Either may be used to express how many, as one may say "I have ten dollars," while another states "I have *three-fourths* of a dollar," or still another says "I have *one-half* a dollar." It appears then that number may be affirmed of *whole things* or *parts of things*, and this suggests two classes of numbers, one de

noting whole things, the other denoting parts of things, called respectively integral and fractional numbers.

To many, no doubt much of the foregoing seems so obvious as scarcely to merit a statement, yet recently an advanced college class in mathematics was puzzled by the question, "is one-half a number?" and the opinions were divided, though a majority thought *not*. The same question propounded to a large convention of teachers, caused a nearly equal division in the opinions expressed, while afterwards an able mathematician, widely known and admitted to be such, expressed serious doubt in regard to the matter, though finally admitting the view here expressed.

The facts just stated, indicate not so much a superficial acquaintance with the subject, as the imperfection of the current methods of presenting the elements of numbers, which should leave such confused notions in the mind, even after subsequent progress had made the problems of the higher mathematics quite familiar. One objected to the existence of fractional number, because "there cannot be such things as three-and-a-half men, or four-and-one fourth sheep." To this it may be answered, that fact simply indicates a feature in the constitution of men and of living beings, which does not permit the existence of life in fractional parts, but in no wise does it impair the flexibility of number which is applicable either to wholes or parts.

In this connection, a practical suggestion occurs, which seems worthy of consideration. Since integral and fractional numbers are two classes of number in general, the exposition of the elementary operations should be applicable alike to both these classes; for instance, the definitions of multiplication and of division should be such as to apply to either integral or fractional numbers. By such means it is believed that the subject of fractional numbers may be divested of much of the difficulty usually encountered by the teacher as well as the pupil.

DISTINCTION BETWEEN NUMBER AND QUANTITY.

Much confusion seems to exist in the minds of many in regard to the notions of number and quantity. This is partly due to the intimate relation of the things, and partly due to the failure of mathematical authors and writers to make the proper discrimination.

The definition of number is often stated to be "the ratio of two magnitudes or quantities," or, it is said, "number is a unit or collection of units of which one is any magnitude assumed as a standard of measure." In making such statements, authors appear to make number depend upon quantity for its existence, and indeed it is

sometimes said, quantity includes both *space and number;* from which it would follow that number is simply one of the kinds of quantity. Prof. Olney says "quantity is the amount or extent of that which may be measured." It seems, however, a better statement to say, quantity expresses the limit of magnitude or extent; in other words, *quantity expresses "how much."*

The difference between number and quantity is precisely of the same kind as that between the notions of *much* and *many.*

It is noticeable that in the form of words, the comparatives of much and many are identical. Thus we say *much, more, most,* and we say, too, *many, more, most;* but the notions of more and most in one case differ from those in the other case in the same way that much differs from many; that is, in the first case more and most relate to quantity, while in the second case they relate to number.

This use of one word to express two ideas or notions, which though related are yet distinct, indicates some confusion in the minds of those whose use of words has given form to our language; but this fact scarcely excuses at the present day any failure on the part of authors and instructors to make the proper discrimination.

In the French and German languages the distinction is less marked than in the English; and so in the Latin, *multus* and *multi* (much and many) differ only in singular and plural forms of the same word. The same is true of the Greek.

NUMBER USED IN THE MEASURE OF QUANTITY.

It follows from the foregoing that it is incorrect to say "number is quantity," though number is often used in *measuring* quantity. It is, in fact, seldom that a quantity is measured in any other way than by meaning the *number* of standard units of quantity contained in the quantity to be measured. For instance, four feet, twelve bushels, twenty acres, illustrate this statement. Yet this fact, though it indicates an important use of number, still does not constitute the basis of a definition, and should not be so misused.

IS MATHEMATICS THE "SCIENCE OF QUANTITY?"

This statement, which has become stereotyped, fails to perform well the office of a definition, even if it does not fail to express the literal truth. The vague use of the term "*quantity*" unfits it to appear as the essential part of a definition. In algebra the current use of this term makes it almost equivalent to the term number, or *symbol of number.* It should be remembered that all algebraic operations are upon number. Thus there can be no multiplication of quantity by quantity; strictly speaking, all multiplication is *purely* by number; and it would seem better in a science, one of whose

chief excellences is *precision*, to call things by their right names. It is believed that a careful consideration will convince any one that all the symbols of algebra are either the symbols of number or of the relations *of* and operations *upon* number. In the application of algebraic principles to problems of quantity, we deal only with the *measure* of quantity in the guise of number. In the elements of geometry, the symbols of magnitude are presented for direct consideration; but in the higher geometry the investigations are made chiefly by algebraic methods; that is, by using the symbols of number to represent the measures of quantities. The statement that mathematics is the science of quantity seems then to be an incomplete definition, if in any true sense it can be called a definition.

ABSTRACT AND CONCRETE NUMBERS.

Perhaps the frequent occurrence of these terms forms a sufficient reason for noticing them in this connection. Number in its very nature is abstract, and it is an obvious misnomer to call it *concrete* in any case. Two means *two things*, and though the kind of things is not explicitly named, the essential character of number is not affected. The statement "two and three are five," means merely "two things and three things counted together are five things." It may be mentioned in passing, that since the office of number is exclusively that of fixing a limit of "how many," the greater or less extent of "how many," does not at all affect the character of the number applicable to the particular case. Thus the number two or three, possesses as completely the character of number as *a thousand* or *a million*. It follows then that *zero* or *naught*, when used, as it often is, to designate the limit of "how many," is properly included under the name number. It is believed that this consideration is not only logically consistent, but that it simplifies the use of *naught*, as well in arithmetic as in algebra, where it often appears as the root of an equation, and in many instances performs as conspicuous and important services as are assigned to any number.

The necessarily brief limits of the present paper do not permit a further examination of these questions at this time; but it is believed enough has been said to show that a thorough revision of the fundamental theory of number is required in order that this branch of instruction should not fall behind in the developments of the day.

ANALYSIS OF CLAYS.

The following brief notes of qualitative and quantitive analyses, taken from my laboratory record, will be of interest to some, and give a general idea of the chemical composition of some of the clays found in so great abundance in this state.

In this form of mineral wealth, Kansas is rich, the list embracing every variety in inexhaustible quantities, from pure white porcelain clay to common marl, and in time it must develop a large and varied manufacturing industry.

Many of you have heard of the Osage City ochre, which is found in an immense bed, varying from twelve to twenty-four feet in thickness. Its composition is—

Silicate of Alumina	Nearly 98 per cent	Silicate of Magnesia	Trace
Silicate of Lime	Small amount	Sesqui-oxide of Iron	Small amount

In that portion of the bed worked at the present time, the percentage of oxide of iron is a little larger than the sample gave from which the analysis was made.

At Council Grove is found an ochre with the same constituents:

Silicate of Alumina	Large amount	Silicate of Magnesia	Trace
Silicate of Lime	Small amount	Sesqui-oxide of Iron	Moderate amount

This ochre has exactly the shade of the *Spanish brown* largely used as a mineral paint, and is in every way equal to it.

The extent of the deposit, its geological position, and its physical characters, I do not know.

Over the eastern half of the state are distributed strata of a light, bluish clay, varying from one to two feet in thickness, lying immediately over or under the coal, commonly called fire clay, but none that I know of are sufficiently pure to furnish first-class refractory fire brick, suitable for furnace linings. Some sufficiently pure, however, will, I believe, eventually be found. Clays sufficiently pure for the manufacture of stone-ware, and other articles that are not required to resist an intense and prolonged heat, are known.

A so-called fire clay found at Council Grove, contains—

Silicates of Alumina and Iron. | Carbonate of Lime. | Sulphate of Lime. | Cloride of Calcium. Carbonate of Magnesia.

The following are found at Carbondale, No. 1 above a coal bed, No. 2 beneath it:

	No. 1.	*No. 2.*
Water, given off at 212° F	8.50	3.00
Organic matter	2.00	2.00
Silica	27.50	48.60
Alumina	39.50	21.85
Protoxide of Iron	18.05	16.70
Sulphate of Lime	3.90	6.80
Sulphate of Magnesia	0.55	1.05
	100.00	100.00

These last from Carbondale are good average samples of the so-called fire clays of Eastern Kansas.

Recently there has been discovered on the line of the K. P. R. W. a beautiful pure white porcelain clay, that remains perfectly white after being subjected to a strong heat. It is apparently pure enough for the manufacture of a fine quality of porcelain, and for many other uses in the arts. The deposit is said to be extensive, uniformly pure and easily worked, characters which if true, make its great value fully assured. Its composition is

Silicate of Alumina. | Silicate of Lime (a trace). | Peroxide of Iron (a trace).

A very pure sample of native rock salt was brought me from the southwestern part of the state, consisting of —

Chloride of Sodium	92.20	Sulphate of Soda	4.91
Chloride of Magnesia	0.81	Silica	2.08
			100.00

The locality from which it was taken, and the extent of the deposit, are unknown to me.

The following analysis will be of general interest, as it shows how powerful diaphoresis can remove from the body by perspiration, mineral compounds that are not ordinarily eliminated through the skin. A gentleman who had been suffering for three years from general debility, decided to try the effects of the Turkish bath. After a few trials finding his condition improved, he desired to know whether any noxious mineral matter was being eliminated by the sweating process, and brought me a sample of perspiration for analysis. After standing a few hours, a residue settled, which was examined separately. The result was as follows :

FILTRATE.

Reaction neutral. Water. Organic matter. Chloride of Sodium. Sulphates of Soda and Potassa. Phosphate of Lime.

RESIDUE.

Organic matter. Alumina. Sesqui-oxide of Iron. Phosphate of Lime.

Attention is called to the presence of alumina, sesqui-oxide of iron, and phosphate of lime, substances that we would not expect to find in perspiration, and which ought not to be eliminated from the system faster than they are naturally excreted. This case must be an exceptional one, I think, as the Turkish bath, for properly-selected cases, is a valuable tonic and remedial agent, that invigorates the system, not a debilitating agent that abstracts the sources of its vitality.

WM. H. SAUNDERS, M. D.

LAWRENCE, October, 1874.

A GEOLOGICAL SURVEY OF KANSAS.

BY B. F. MUDGE.

We have an area of territory ten times as large as Massachusetts (78,000 square miles) much of it only yet visited by the hunter, and the geological character of even the settled portions but little understood.

Enough coal exists, at least for a home supply for ordinary domestic heating purposes. But even when valuable for generating heat, how much is known in relation to its worth for making gas, smelting iron ore, or for the common uses of blacksmithing?

We have, if we believe the newspapers, plenty of magnesian limestone in all parts of the state; but who knows how much or how little of it has any magnesia in it, or whether it has any of those properties which make true magnesian limestone available for hydraulic or Roman cement? We have, on the same authority, plenty of slate; but how many know if it is the genuine article? We might go on asking the same questions about a dozen other products found, or said to be found, in our state.

Much time and money are being expended in the useless search for metals, when only two — iron and lead — can by any possibility be found in the state, and those in a narrow area, where the chances are very strongly against us. We have coal in half the counties of the state, but a considerable portion is utterly worthless. Much is frequently worked and carried to some adjoining market, only to disappoint both the miner and purchaser. At the same time our best coal seam, which would be counted good in Pennsylvania, is little worked and less known, than the inferior article. We hear of constant expenditures in boring and digging for coal, where a geologist could easily decide that no coal could be found. Enough has been spent in half a dozen Kansas cities, ignorantly and uselessly searching for coal, to pay for a full, economical and scientific survey of the state. We cite one example for illustration: A city with more enterprise than confidence in geology, though frequently advised by me that no paying coal lay within one thousand feet of the surface, commenced the search, boasting through the press that the proceeding was "contrary to all principles of science," and "against the advice of one of the best geologists in Kansas," adding, "but we have got the coal." After boring three hundred feet, and striking dark shale, a shaft was opened at an expense of over $25,000, only to find a black, worthless substance, which was not coal, and would

not burn. Council Grove is not the only place in Kansas that has spent capital to bore for coal "contrary to all the principles of geological science." A few such expenditures as the above would be all the most extravagant geologist would require for a full, scien tific survey of the entire state.

Other articles beside coal, require investigation. Our gypsum is abundant and valuable, but almost unknown to our citizens. Salt is found in large quantities, but only the small deposits of weakest brines are yet worked, while this valuable article is brought a thousand miles to our market. We should, instead, be sending our very superior salt to all the neighboring states.

Nor should the scientific aspect of the survey be overlooked. We have a flora in many respects unlike the more easterly portions of our country. We want a knowledge of our insects as well for science as the farmers. The chemical analysis of our soils and building materials and few minerals, is equally important to all. Our fauna is peculiar, and some of it rapidly disappearing. We have some geological formations (Permian, for instance) little represented in the United States; and others so rich in new forms of ancient life, that Eastern colleges and institutions are procuring them by tons, and we, in future, may be obliged for our collections to glean from their leavings. Kansas has probably presented to science, during the past eight years, more new species of fossils than any other state in the Union. And this only by the unaided labors of private enterprise. Much more could be done by a little State aid, and the specimens and credit preserved for Kansas. We should not be behind other states in this respect. Not only are Missouri and Iowa leading us in this matter, but many of the southern states have organized, or are organizing, their geological surveys. We should not be less enterprising. We cannot promise the discovery of any precious metals as the result, yet a knowledge of the mineral contents of our strata will richly repay the small cost necessary. No better advertisement can be made to draw immigration, than a geological report. A true knowledge of the geological character of Kansas should be sent abroad. While writing this article, an official document from the national land department at Washington comes to me with a most gross misstatement of our coal fields. Such errors should be corrected by official reports from home. Nothing would so economically prevent the useless waste of time and money in search of possible products of the soil. The saving to the people at large would, in this respect, be ten-fold, and from the pockets of those who can ill afford the expense.

DISCREPANCIES BETWEEN THEORY AND OBSERVATION OF THE MOON'S MOTION.

BY F. W. BARDWELL.

In studying recently the question of the moon's irregularities, I discovered an apparent source of error affecting lunar computations, whose explanation will probably interest many scientists, though of more special value to the astronomer.

The problem of the moon's motion has been one of the most interesting, though troublesome, in the series which astronomers have attacked with such success, as one by one the difficulties have been overcome, and the victors received their well-earned honors. Yet it is well known that the differences between the predicted and observed places of the moon are greater than in the case of any other heavenly body, and that these discrepancies have excited the special efforts of investigators.

Thus a comparison of the Washington observations with the American Ephemeris for 1870, indicates errors in the predicted right ascension of the moon, extending from +0.4s. to —0.7s.

Among the interesting phenomena dependent upon the motions of the moon, lunar and solar eclipses are conspicuous, and observations of these have naturally been used in the determination of elements or in the verification of theories, and any error pertaining to such observations would serve to introduce error into lunar tables.

An eclipse of the moon occurs when she passes into the earth's shadow, and the axis or central line of the earth's shadow is usually reckoned as the prolongation of the line connecting the center of the sun with the center of the earth. But this supposition contains an appreciable error. For since light requires an appreciable extent of time to pass from the earth to the moon, the earth advances in her orbit during that small interval, so that the part of the shadow found at any distance from the earth, say at the moon, lags a little behind the corresponding place of the earth.

It may easily be shown that the axis of the earth's shadow thus lags by an angle of about 20″ — equal to the angle of aberration — and as the entire cone of shadow tends to lag equally in angular measurement, it will follow that the eclipse will begin and end earlier than if the earth's shadow were projected directly behind itself.

In other words, the central moment of a lunar eclipse does not coincide with the instant of the moon's opposition, but differs by the time required for the moon to gain about 20″ relatively to the earth's

position in her orbit, which may be 40 or 50 seconds of time or more.

In the case of a solar eclipse, some of these relations are reversed, though the result is nearly the same. Considering the motions of the earth and moon with reference to the sun, the moon is first in advance of the earth, while the earth is gaining upon her, but as the moon's shadow lags also, so the earth encounters it earlier, and by nearly the same interval of time, as happened in the case of the lunar eclipse, and the central moment of the solar eclipse occurs before the instant of conjunction.

It follows, then, that a lunar theory which includes the supposition that the central moments of lunar and solar eclipses indicate the instants of opposition and conjunction must involve an appreciable error, which would affect the tables based upon it.

It is noticeable that the error here pointed out—20″ in longitude —corresponding to about 1.3 s. in right ascension, expresses so nearly the range of the discrepancies between the lunar tables and the results of observation.

Whether the elimination of the effects of this error would serve to reconcile completely theory and observation, can only be decided by actual experiment, but it seems reasonable to expect much from such an elimination.

The lagging of the shadows suggests other curious deductions, which may be mentioned:

When the transit of Venus occurs, she will not, in the ordinary sense of the word, be *seen* upon the disc of the sun, but she will intercept certain rays of light, while only the *place* of the intercepted rays is perceived. But the place of these rays, or the shadow, lags, and, since the velocity of Venus is greater than that of the earth, the angle of lagging is greater than in the case of the earth's shadow. It will happen, then, that Venus will be in a line with a tangent to the sun and earth several minutes before an observer on the earth can perceive the indications.

If Venus were able to shine and make her light perceptible while passing in front of the sun, she would be perceived sooner than will actually be the case, and all the circumstances of the transit will appear later on this account.

The angle of aberration due to the velocity of Venus is about 24″, and, since this measures the angle of lagging, the shadow will not overtake the earth until Venus shall have advanced about 24″ past the line of tangency. The hourly motions being respectively +10.980 s. and 6.267 s. in right ascension, it will require about five minutes to accomplish the passage, and this interval indicates the apparent delay that may be expected.

Again, in the case of the solar eclipse, the absolute velocity of the moon is less than that of the earth, by a difference due to the velocity of the moon about the earth, which may be determined with a good degree of accuracy. The angle of lagging will, therefore, be less, and the time occupied by the earth in gaining it will also be less, so that the change in the angle of aberration, due to the velocity of the moon about the earth, will be indicated on a magnified scale.

The ratio of this change to the entire angle of aberration would again indicate the absolute velocity of light, knowing which, and the time occupied by light in coming to us from the sun, the distance of the sun becomes determinable.

The value of this method of determining the solar parallax will depend upon the precision of the lunar tables; but, with the elimination of the effects of the error above explained, it is possible such precision may be attained as shall make the method valuable.

The comparative frequency of eclipses would enable astronomers to accumulate observations rapidly, and the more rapidly reduce the degree of error.

POSTSCRIPT.

The foregoing remains the same as originally prepared, though from further inquiry it appears that in the case of the lunar and solar eclipses *apparent* instead of *true* geocentric opposition and conjunction are understood in the elements given in the Nautical Almanac for those computations, so that no error in the moon's place could thus occur. A similar remark applies in the case of the transit of Venus.

The fact of the lagging of planetary shadows seems, however, to deserve recognition, though it furnishes no aid in the attempt to diminish the discrepancies between lunar theory and observation. And though these discrepancies are still so great as to indicate a specific cause which has so far eluded discovery, it is yet reasonable to believe that the true cause lies within the operations of known law; that this cause will ultimately be found out, when the moon will appear to move completely subject to the law of gravitation, and will conform gracefully to the predictions of astronomers.

LAWRENCE, KANSAS, December 7, 1874.

ON TIN "SALTING" ENTERPRISES IN THE UNITED STATES.

BY PROF. WM. K. KEDZIE.

Among the many elements which enter into, and add to the completeness of what we in egotistic phraseology term "our modern civilization," there are many most vitally important in their relations to the wants and necessities of civilized life, for which modern civilization is in no way responsible. They are the product, not of modern enterprise or industry; on the contrary, they are an inheritance, handed down to us from a remote and barbaric past.

Not the least important in its multitudinous and vital relations to the usages of civilized life, and for which we here to-day are mutually debtors to *pre*-civilized enterprise, may be mentioned the metal, TIN. The mere mention of the metal calls up before us the thousand-and-one uses and purposes which it subserves in every-day life. Whether in the form of block tin, or as a coating to inferior but more durable metals, such as iron or copper, or in the beautifully semi-crystalized condition known as *moire metallique*, or in the form of foil of one one-thousandth of an inch in thickness --so indispensable in the manufacture of mirrors; its brightness and beauty, almost equaling that of silver; its durability in air at ordinary temperatures — all conspire to render it a metal of incalculable value in the manufacture of articles of ornament and of every-day use.

And yet indispensable as we in this age and country have learned to regard this metal, it is interesting and instructive to note how little actual progress in the mining and metallurgy of tin has been made in the last three thousand years. For by this you will see that I place the discovery and first manufacture of tin from its ores, at a point far antedating the birth of the Christian era. No learned savant in the old world of alchemy has been able to hand his name down to posterity, linked with so all important a discovery.

To give the exact date of the introduction of tin would be quite as impossible and as difficult as to name the discoverer of gunpowder, or of the manufacture of glass. In the books of Moses we are told at one point of the "gold and the silver, the brass and the *tin*." Under the cabalistic sobriquet of *Kassiteros*, Homer sings of

it in the Iliad, as that which gave strength and splendor to the battle-shields of Trojan warriors. By the writings of Pliny and others, we know that as early as between the years 1030 and 1040 before the birth of Christ, the Phœnicians had begun to avail themselves of the immense tin deposits of Cornwall, in the British Isles. And strange as it may appear, these same old mines of Cornwall, after 3,000 years of hard usage, are still the great tin producers of the world, giving us annually from their apparently inexhaustible resources 140,000 hundred-weight of the pure metal. Since the time when the Phœnicians began the transportation of this metal across the English Channel, how comparatively little has been accomplished in the new discovery and developement of tin deposits. To be sure, we now have the mines of Banca and Malacca, yielding their annual 100,000 hundred-weight. Then, too, there are the remarkable mines of Bolivia, the reported yield of which has however, in all probability, been greatly exaggerated. Then may be enumerated the lesser deposits of Bohemia, Saxony, and Australia, and associated with the mineral Cryolite ($Al_2F_3,3NaF$,) to some considerable extent in Greenland. The Australian tin ore contains also so large a percentage of gold that it may be extracted with profit. Within the past year also a new deposit of most promising character has been discovered upon the MacIntyre river in Australia, which bids fair to rival either Cornwall or Banca in its wealth.

The remarkable absence of anything approaching the character of tin deposits in the United States has been a most unwelcome fact which has long perplexed mineralogists. Not that the mineral *Cassiterite* or *Tin Stone* is entirely absent; for very slight deposits may be found near the town of Chesterfield, Pa.—associated with albite and tourmaline—also near Jackson, N. H., Paris, Maine, in the gold fields of Virginia, in Idaho, and in California. But in all these localities the metal exists only in such quantities as to be purely of mineralogical, never of metallurgical importance. It is but proper to remark, however, that the supposition is entertained by some that the deposits of San Bernardino county, California, may yet prove of commercial interest, when more fully examined.

Now in a territory so richly endowed as is that of the United States, with all the mineralogical wealth that the needs of a high civilization could demand, this lamentable poverty in the matter of tin deposits evinces an unwarrantable short-sightedness on the part of nature. To be compelled to resort to our more favored English brethren on the other side of the Atlantic for a requisite supply of the needed metal has long been a subject of national chargin. This

impoverished condition of our tin resources has plainly been long felt by American patriotism as a great and a national reproach upon the character of a progressive commonwealth! At least upon no other adequate basis can we explain the efforts to supply this deficiency by the innumerable *tin-salting enterprises* which the last twenty years have witnessed in this country, some of which have been conceived and carried out upon a stupendous scale and with unfaltering energy. It is among these undertakings that the recent "tin mountain" excitement in Missouri may be classified; in some respects one of the most laughable instances in the whole calendar of tin frauds, closing with a grand railroad excursion, in which a credulous public is said to have stood gaping around two chemists, who were supposed to have produced the metal from a rock about as destitute of true cassiterite (tin stone) as a specimen of Jura limestone!

It is among these instances that these isolated "tin discoveries" are, even in our midst in Kansas, constantly taking place. I am in constant receipt, at my laboratory, of packages of ore from various parts of the State, supposed to abound in tin. Not infrequently a neat little ingot of the pure metal, said to have been found in close proximity to the ore, accompanies each package — the discoverer evidently forgetting that pure tin is one of the rarest elements in the whole realm of mineralogy. But it is to one of these enterprises in particular, even now in progress, and which can hardly be considered other than a case of "salting," that I desire to-day to call your attention, having been myself an amused spectator of the undertaking. I refer to the "Otter Head Consolidated Tin Land Pool" of the region north of Lake Superior. The marvelous accounts of this territory report it as furnishing not only the sulphide of tin, ($Sn\ S_2$ generally combined with sulphides of iron and copper,) which has hitherto been known only in Cornwall, England, where it passes under the name of bell-metal ore, but in addition also an abundance of the genuine Cassiterite—tin-stone ($Sn\ O_2$)—in all its forms of hard, brown-black, glittering octahedral crystals; before the blowpipe alone infusible, but readily yielding globules of metallic tin when fused upon charcoal with a flux. The modifications of Cassiterite are also said to be here afforded in their various botryoidal forms known as "wood-tin" and "toad's eye," from its peculiarly concentric and radiated structure; and last but most incredible part of the whole account, *native* or *metallic tin* which heretofore has been known only as an exceedingly rare native metal, found occasionally in the gold washings of Bolivia and in Siberia. Early in the past year an elaborate article appeared in the New York *Herald*, giving an account

of the supposed discovery of these mines. It seems that some years ago, off the entrance to Thunder Bay, on Lake Superior, the famous Silver Islet was discovered, which now, under the direction of a large company, is yielding an immense profit. Stimulated by this discovery, the whole north shore of the lake was soon covered by earnest explorers. As a portion of the fruit of their investigations, gold in quartzose rock was said to have been found in the region about Shenandowan Lake, though in consequence of an unsettled dispute between the provinces of Manitoba and Ontario as to the right and title of the land, the discovery was maintained a profound secret. A portion of this same party of discoverers operating in other directions toward the south and east, reported themselves as finding, in the immediate vicinity of Otter Head, on the Canada shore, extensive veins of dark-colored ore of a high specific gravity, specimens of which they brought with them on returning. These specimens are filled with well-defined crystals of Cassiterite, which may readily be detected with a glass of low magnifying power. Upon assay they yield an abundance of metallic tin. It is said that the discoverers first supposed them to be iron ores, on account of their dark color, but the assay failed to yield metallic iron in sufficient quantity to account for their high specific gravity. A white metal was also produced as a part product of the assay, and was at first taken to be silver, as silver was the metal they were seeking. A more critical examination, however, proved this product to be metallic tin.

This valuable metal being heretofore supposed to be an utter stranger upon this continent, this supposed discovery created, as might have been expected, much comment and an unusual degree of interest. No more propitious a locality for such a venture, supposing it to be a fraudulent one, could have been possibly conceived. Around the exact point of the so-called discovery, at Otter Head, about midway between the canal of Sault Ste. Marie and Thunder bay, the country is eminently wild, solitary and romantic. Heavy granite cliffs rise from the shore of the lake to the height of a thousand feet. A few wandering Chippewa Indians may be found in the district, but not a white man can be seen within fifty miles of this point. From the extremely precipitous character of the territory, extensive inland travel is an utter impossibility; hence, much of the exploration must be confined to the lake shore. Early in May, 1873, I received from the secretary of the "Otter Head Tin Pool" a considerable quantity of the ore, accompanied by a printed pamphlet embodying the report of the trustees of the company. The ore was certainly of an unexceptionable character, dark-gray in

color, and heavily charged with crystals of Cassiterite. Much of it was in the condition called stream tin — a rich, fine ore, produced by the washing action of running water. It yielded on assay from fifteen to thirty-five per cent. of clean metal. This ore was also remarkably free from the injurious mineral Wolframite (tungstate of iron and manganese - Fe Mn WO_4), from which, as its specific gravity is nearly the same as that of Cassiterite, it is frequently extremely difficult to separate the ore. I also forwarded specimens of the ore to Prof. O. D. Allen, of the Sheffield Scientific School of Yale College, who stands as the acknowledged head of American metallurgy. He pronounced the specimens rich in tin, but at the same time intimated to me his suspicions that the enterprise was a "salted" one. Dr. John Torrey, of the United States assay office at New York city, before his death, also assayed the ore, and reported as follows: "The ore is a true Cassiterite, or tin-stone mixed with quartz; some of it is massive, but a considerable portion of the examined specimen is in the form of small, translucent, quadrangular prisms, some of which are perfectly terminated. The average of the samples yielded 33.3 per cent. of metallic tin." Similar assays were also made by Dr. Jennings, of Detroit, and by Drown and Carliss, of Philadelphia, all testifying to the promising character of the ore. When we remember that pure Cassiterite itself affords but 78.38 per cent. metallic tin, we can better appreciate the rich results obtained by Dr. Torrey.

Stimulated by these flattering indications, the company already designated as the "Otter Head Tin Land Pool," was organized, a tract of land to the extent of 28,314½ acres was purchased, shares issued and thrown upon the market, and, as may be supposed, were for a time in ready demand. In the report of the trustees of this organization are displayed apparently well-authenticated accounts of individuals exploring this region. The veins are described as well defined, and fully five hundred in number. Their courses are said to be generally well marked from northeast to southwest, with a dip of eighty degrees to the south. In width they are said to vary from an inch to six and eight feet, and to extend miles inland. The veins are also said to cross each other, forming at their intersections deposits designated by the Germans as *stockwert*. The value of the dressed ores, as given in the report, is estimated to vary from $23 to $369 per ton. But notwithstanding all these very promising indications and the apparently frank and minute statement of details, many doubtful circumstances soon created suspicion that the whole enterprise was a "salted" undertaking. Time has only served to confirm this suspicion in the minds of many, and the market value

of the stock is now immensely depreciated. If such should prove to be the case, the query now arises, from whence was this rich ore obtained? Rumors have reported the finding of the boxes and barrels in which the ore was supposed to have been transported, in close proximity to the so-called veins; and also of the vessels in which the metallic tin was melted and judiciously distributed, though the latter can hardly be accredited. But let us remember that such an undertaking by no means argues a dishonest purpose in the minds of many or even most of those engaged therein. This consolidated Tin Land Pool numbers among its members many sincere and honorable men, who are now extensively purchasing the stock at its greatly depreciated value. But let us also bear in mind that the problem of deceiving even skilled metallurgists is by no means a difficult one. How much more easily, then, may those be misled who are unschooled by experience in mining matters?

The chemist, in collecting his specimens from the mine which he is called upon to examine, gathers them in small canvas bags. These, speedily becoming too heavy for convenient transportation, are deposited at convenient points, to be collected at the close of the exploration. How easy to replace them by similar bags containing a far richer ore! It was by this very process that an Eastern capitalist was recently very nearly swindled out of $206,000 by the analysis of his own chemist.

In conclusion, then, until the "Lake Superior Tin Land Pool" shall have given us abundant pledges of its good faith in the form of ingots of fine tin thrown upon the market, we cannot do otherwise than number it as one of the great fraudulent enterprises of the age.

K. S. A. C. CHEMICAL DEPARTMENT, October, 1874.

BRACHIOSPONGIA.

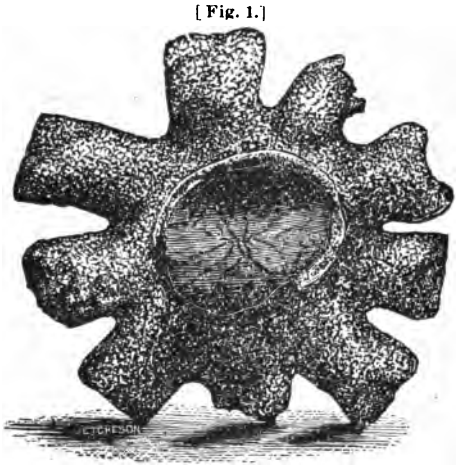
BY REV. HORACE C. HOVEY, M. A.

During a geological trip in 1855, I discovered a new genus of fossil sponge, which, although extra-limital, may be worthy of a brief notice. My first specimen was exhibited to Prof. L. P. Yardell, of Louisville, Kentucky, and while in his hands it was seen and described by Prof. D. D. Owen. (Second Report of Geology of Kentucky, p. 111.) He styled it an amorphozoon, and suggested the name of "*Scyphia digitata*." I doubt if he ever saw the fossil in

place, though he correctly refers it to the Birdseye group of the Lower Silurian. It was again described and imperfectly figured by Prof. R. Owen. (Indiana Geological Survey, 1859-60, pp. 362, 363.) He changed the name to *Syphonia digitata*, and he recognized it as a sponge. The specimen thus described, having nine arms, I claim as my discovery, and it should be acknowledged as typical of the genus. Prof. S. S. Lyon afterward found one with eleven arms, of which casts have been widely distributed. In 1867 I placed my original specimen in the hands of that accomplished naturalist, Prof. O. C. Marsh, of Yale College, for a more careful examination. The result was the rejection of the former unsuitable names and the substitution of *Brachiospongia*, (the arm-bearing sponge), with the specific name of *Roemerana*, in honor of Prof. F. Roemer, the leading authority on paleozoic sponges. Over fifty additional specimens, complete or fragmentary, were obtained by me on a subsequent visit to Franklin county, Kentucky, and a map of the sponge region was prepared. Specimens have also been found in the same geological horizon in Tennessee. Allied forms were likewise found, but they were so highly silicified and distorted as to make an accurate description impracticable. Prof. Marsh's notice appeared in the *American Journal of Science and Arts*, vol. 44, p. 88; and it was afterward corrected and and elaborated in the form of a paper read before the American Science Association in 1868.

Figure 1 represents *B. Roemerana*.

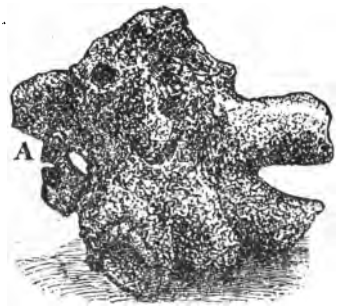
[Fig. 1.]



The general appearance of the *Brachiospongia* is vasiform; a central cup, oval, with a rim one or two inches high, being surrounded by tubular arms or fingars, hollow at the base, and closed at the extremity. These arms vary in number, from five to twelve; and on

this variation specific distinctions are founded. The smallest sponge of this kind thus far found is three inches in diameter, and the largest, twelve inches. Frequently the fingers were found detached from the body; and in one case two large ones were found near each other, having so grotesque a resemblance to a pair of diminutive human feet that for a time my assistants positively refused to aid me further! The exterior of the *Brachiospongia* is silicified, while through the interior characteristic silicious spicules are distributed. Near the center of the base, and opposite the mouth of the cup, is a small papilliform cone, which others have regarded as the point by which the sponge was attached to its support. But, in my opinion, this is a hasty conclusion; and I think it can be shown that this basal protuberance is the remnant of a partially absorbed arm. In a specimen of *B. Hoveyii* (Marsh), having twelve arms, only six of which appear in the figure (see fig. 2), there is evidence that the sponge arms, though constant in their specific numbers, were at intervals liable to alternate absorption and reproduction. The arm, marked A, seems to be the youngest in a series of which the basal cone, marked B, is the retiring member. A more careful study of these curious and highly interesting fossils may serve to throw light upon the mysterious laws of spongoidal growth.

[Fig. 2.]



PLIOCENE TERTIARY OF WESTERN KANSAS.

BY B. F. MUDGE.

The Tertiary deposits of Western Kansas have been but little examined, and consequently our knowledge of the peculiar character of its geology is quite limited. The exceedingly rich and varied fossils of the Cretaceous (Niobrara group) immediately under it, have probably led to its neglect. Even its extent has hardly been noticed. Professors Cope and Marsh have both in their visits to the

Cretaceous made some casual notices of it, without spending much time in searching for its fossils. The writer, in the summer of 1872, spent a fortnight in its examination in the vicinity of Prairie Dog creek, but as the deposit was there very barren of organic remains, little satisfaction was obtained. During the past summer and fall we have been engaged in careful exploration of the Cretaceous, lying immediately under it, and consequently have seen it over a wide extent, and found its fossils more numerous and more varied in character than we had at first supposed.

In tracing its limits, we find it most easterly in the northern part of Smith county, where it is seen only on the tops of the highest hills. Its position there as elsewhere is very nearly horizontal, but usually dipping slightly (not more than five or eight feet to the mile) northwesterly. As the country rises about eight feet to the mile toward the headwaters of the Republican and Solomon, the deposits in question gradually descend lower down, and in Norton county entirely compose the hills, and fill the valleys and ravines. It then continues to the extreme western boundary of Kansas. Thus it extends on the Nebraska line, on the hilltops of Smith and Phillips counties, about fifty miles, and then, becoming the only deposit seen in Norton and other westerly counties, for one hundred and twenty miles farther, or a total of one hundred and seventy miles within the bounds of our state. Tracing its boundaries southerly and westerly, we find its limits bending rather rapidly toward Colorado.

It is not found in the southern part of Smith or Phillips counties; and in Rooks county, still farther south and west, it is seen only in the western portion, crossing the Solomon on the hills in the vicinity of Logan. From thence it tends more directly south, and is found on all the hills in the northeastern part of Ellis county, on both sides of the Saline river. It does not, however, cross to the Smoky Hill river, twenty miles distant, for the next seventy-five miles. It turns toward Colorado, and is not seen again in the lower valleys, but only as a landmark forming the tops of the hills. In the vicinity of Fort Wallace, it appears south of the Smoky, and is seen occasionally for forty miles south and southeast of that place.

On examination of the country westerly of the boundary given, we shall find that the Pliocene occupies, in common with the Cretaceous (Niobrara group), about one-half of the area of the country for three thousand square miles, while it entirely covers the northwestern part of Kansas to the extent of about twice that number, or six thousand square miles. It will thus be seen that if a geological map were to be made of the Pliocene, its outlines on the east

and south would be very irregular; the higher portions of the country presenting the sandstones of the Pliocene, while the ravines and valleys would show the chalky limestones and shales of the Cretaceous.

The fossils which we at first supposed rare in the Pliocene, were found in our later visit more abundant and very interesting. As our labors the past six months were devoted to the collection of vertebrate fossils from the Niobrara, our examination of the former was casual, and only along the line of their union. The fossils of the two were found in situ and within ten vertical feet of each other, and frequently in the shales mingled together. The contrast is very great. While the Cretaceous are nearly all marine, with no mammals, those of the other are nearly all mammalia of modern types.

The Pliocene gave us bones of deer, beaver, a larger animal of the ox family, two species of horse, less in size than our smallest Indian ponies, a wolf, ivory from the mastodon or elephant, bones of the rhinoceros and camel, also some remains of an undetermined character. In addition to these we have the the bones and carapace of a large fresh-water turtle, five feet in length, and a few obscure marine fossils; also what appear to be the casts of stems of water-plants. All these, as may readily be considered, are of extinct species, and some of extinct genera. All the bones are fossilized, and most of them changed to hard, compact silica. The most interesting of these is the ivory. In the process of petrifaction, the tusk must have been so softened as to admit the intermixture of black oxyd of manganese* in solution, which then crystalized in delicate sprigs. The ivory was then silicified into nearly pure quartz, with the hardness of that substance. Thus we have the ivory converted to the so-called moss agate. Some fragments could not be detected in appearance from that gem. Specimens of it have been sent to the cabinet of Yale, and a few are deposited in our collection of the Kansas Academy of Science.† The agencies of nature that changed this ivory to silicious moss agate must have been somewhat similar to the hot springs of Iceland and the Yellowstone Park. Those springs will change organic substances to silica—the only known natural agency which will do so in a thorough manner.

The materials of the Tertiary-Pliocene are in as strong contrast with those of the Cretaceous as are the fossils. While the latter is composed of fine-grained chalk and shales, the former is of silicious sand, in many places intermingled with coarse pebbles of metamor-

* On a chemical test, by Prof. Kedzie, some *iron* was found with the manganese.
† They were submitted to the inspection of the members at the reading of this article.

phic rock. For the most part, the sandstone is in a very friable state, crumbling on exposure to the atmosphere; and where it is more compact, its mechanical composition is so irregular as to render it almost entirely unfit for a building material. When firmly consolidated, it forms the tops of the table-like hills of northwestern Kansas. At Bread-Bowl Mound, in Phillips county, it is nearly two hundred feet above the water of Deer creek, and at Sugar Mound, in the western part of Rooks county, which is nearly three hundred feet above the waters of the Solomon, it forms seventy five feet of the upper portion. Farther west, it occupies the whole of the visible deposit, and the mounds are not so prominent. On Prairie Dog Creek, in Norton county, it is about four hundred feet in thickness. Beyond, westward, we have reason to believe that the formation is still thicker. Our time and engagements have never allowed us to visit in the extreme western counties.

The occurrence of moss agates (as they are called) on the plains, in the western part of the state, is well known. Beautiful specimens have been picked up, and are frequently worn as jewelry. As they are found in the loose gravel, they have been supposed to owe their present deposit to drift, their original home having been in the north. But I was somewhat surprised to find that they originated in the Pliocene deposit, within the bounds of western Kansas, near their present position. In Wallace county, this Pliocene consists of a silicious deposit, formed of material varying from coarse flint-quartz, to chalcedony, milk-white to transparent; sometimes presenting a fine semi-opal appearance. Oxyd of manganese, more or less crystalized in minute, moss-like sprigs, extend through the whole strata of eight feet. The lower part is formed of the coarser materials, and it is only in the upper six inches that we find any moss agate fit for the lapidary. Some of them are very fine and transparent. The whole mass is extremely interesting to the mineralogist, as showing the moss agate in the whole process of formation. The lower portion indicates an imperfect chemical solution of the silica and oxyd of manganese, therefore the crystalization is imperfect; while the upper inch, or half-inch, contains the best specimens, evincing the deposit in a higher state of chemical development.

The fossil ivory must have been subjected to this same chemical process. This deposit I first noticed as the broken cap-rock of the two buttes two miles southwest of Sheridan, and half a mile from the line of the Kansas Pacific railway. They form a notable landmark to travelers. It in like manner forms the cap-rock of all the high hills of that vicinity. It retains its thickness near Fort Wallace,

but twenty-five miles south of Chalk creek had decreased one-half, and the best agates were only in the caps of two inches. The disintegration of the sand-rock would of itself give a poor soil. While this is its character in many places, in others we found a mixture of vegetation, which was fertile. Springs and streams are not abundant, but where found (like others in sandstone regions), the water is good; and we will add, that in all our experience of eight summers camping in western Kansas, *we have never met with a single "alkali" spring, or a single acre white with alkali deposit.* There are a few, and but a few, salt springs which may at some day be made useful in furnishing settlers with salt.

We have thus given a few notes of this important geological formation, showing how little we yet know of our own territory.

ON DETERMINING THE SOLUBILITIES OF METALLIC SALTS.

BY PROFS. GEO. E. PATRICK* AND ALFRED B. AUBERT.†

The determination of the solubility of a metallic salt in water or other solvent is apparently a matter so simple and so easy of execution as to offer little difficulty to the chemist; and hence one would naturally expect that the results of different chemists, who have investigated the solubility of the same salt, would show the greatest concordance. But notwithstanding this apparent simplicity, any one who has reviewed the subject must admit that the results obtained by different workers in this field show a lamentable lack of harmony. This lack of harmony must be due to the neglect of certain precautions essential to accurate work, which precautions must relate to one or all of the following points:

I. Purity of material.

II. Degree of saturation of the solvent at the temperatures at which the determinations are made.

III. Reliability of the process by which the amount of dissolved salt is estimated, and accuracy in the execution of that process.

Upon the first and third points the liability to error is comparatively slight, the exercise of ordinary care only being necessary. But upon the second point there is the greatest danger of error; for unless special precautions are taken, it is difficult to obtain a solution at any given temperature, containing the *normal amount* of salt for

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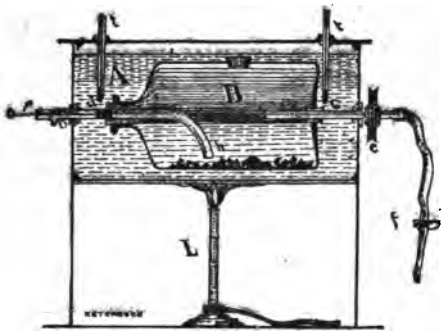
†Professor of Chemistry in Maine Agricultural College.

that temperature, *and no more;* for it is now quite well established that the ability to form *super-saturated* solutions, so strikingly exhibited by sodic sulphate (Glauber's salt), is likewise possessed in some degree by all salts — by most, it is true, in so slight a degree as to be, under ordinary circumstances and for ordinary purposes, quite inappreciable, but in such a degree, however, as to furnish ground for the belief that, unless carefully guarded against, it may, in the determination of solubilities, materially vitiate the results. Indeed, it seems probable that to the phenomenon of super-saturation are due most of the discrepancies so apparent between the different tables of solubilities. In support of this conclusion, we would refer to the manner in which the determinations of solubilities have, as a rule, been conducted.

The plan usually adopted is: to make a saturated solution of the salt at the boiling point of the solvent (or of the saturated solution) and allow it to cool gradually, with frequent or occasional agitation by the hand to prevent super-saturation, to the respective temperatures at which the determinations are made; at which temperatures portions of the liquid are withdrawn, and the amounts of dry salt contained therein determined.

By such a method, where the temperature is being continually lowered, and there are no means of constant agitation, there is evidently a possibility, if not a probability, that super-saturation will occur. It was the object of the work herein described to ascertain if it were not possible, by a simple mechanical contrivance and a different method of work, to avoid the errors arising from this cause; and to that end was employed the apparatus figured below. It consists of a copper tank *A* (shown here in section), inside of which revolves a bottle *B*, containing the salt to be dissolved and the solvent. This bottle is perforated at the base and at the side. Though the perforation at the base, fitted tightly with a rubber stopper, passes a glass tube *c c*, having its outer end closed by a rubber tube and a pinch-clamp *f*. This tube serves as an axis of revolution, the power being applied by means of a cord passing over the grooved wheel *e e*, which is firmly attached to the tube *c c*, just outside the tank. The same tube also furnishes a means of producing pressure in the bottle sufficient to force out the solution through another tube *d d*, passing through a tight stopper in the neck of the bottle, which tube also serves as the axis of revolution. This tube is furnished with a tightly fitting piston *p;* and at a short distance outside the tank it has an orifice *o*, through which, when the piston is drawn out beyond that point, the solution is forced. Within the bottle this

tube is bent so as to allow its end *h*, to be under the surface of the liquid in the bottle, even when but little remains.



The perforation *g* at the side, fitted tightly with a stopper, is for the purpose of introducing crystals of the salt as often as necessary, to keep the latter in excess of the solvent.

The lamp *L*, beneath the tank, serves to regulate the temperature, which is indicated by the two thermometers, *t t*.

For maintaining the bottle in revolution, any constant power may of course be used; but in the work already done with this apparatus, the motor employed has been a small electro-magnetic engine, excited by two Bunsen elements.

Our method of work is as follows: A large amount of the salt is introduced into the bottle (the amount depending of course upon the solubility of the salt under examination), the bottle nearly filled with distilled water, and put firmly in place. The tank is filled with water to a level above the top of the bottle, the latter set in revolution by the motor, and the lamp lighted. The temperature of the water in the tank, indicated by two *trusty* thermometers, is slowly raised to the *lowest* temperature at which a determination is to be made, and carefully kept at that point for one-half hour (or longer, if that is found insufficient for obtaining a saturated solution), special care being taken to avoid its getting at all — even a fraction of a degree — *above* the desired point, in order that super-saturation may be absolutely impossible.

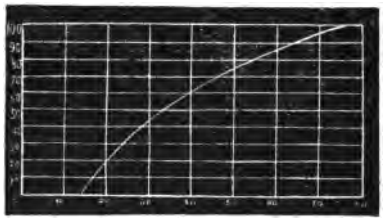
At the end of one half-hour (or longer, if necessary) at that temperature, the machine is stopped and allowed to remain quiet ten or fifteen minutes, that the crystals may settle; the tube *dd* being turned at such an angle that the end *h* is in clear liquid, and not in the vicinity of crystals. A drawing is then made in the following manner: The piston *p* is drawn out until the opening *o* is cleared. One person blows into the bottle through the tube *cc* and its rubber attachment, at the same time pressing the clamp *f*, while another holds

a tarred beaker provided with a ground-glass cover (the beaker itself having a ground edge) under the orifice *o* until the proper amount of solution is obtained. The ground-glass cover is quickly placed on the beaker, the whole is allowed to cool, and is then weighed. The amount of salt dissolved in that amount of solution is then determined by the most reliable and convenient method.

Parallel determinations were always made, the second drawing being made about one quarter-hour after the first, the bottle meantime having been kept in revolution, and the temperature constant. The determinations were made usually at intervals of 10° C., ranging from 0° or 10° to 90° or 100°.

In this way the solubilities of salts have been determined, both singly (one salt alone in water), and mixed (two salts, both present in excess of the solvent), with uniformly gratifying results, the curves being in each case more regular than any previously obtained; and all the results, with very few exceptions, show upon comparison with those on record, obtained by the old method of work, smaller amounts of salt dissolved at the respective temperatures—a fact which goes far to prove that super-saturation has, in some cases at least, been a vitiating element in the work.

We give below the curve for the solubility of anhydrous cupric sulphate ($Cu\,SO_4$,) based upon the figures obtained by us, representing the number of parts of the anhydrous salt soluble in one hundred parts of water. We also give for comparison the figures actually obtained for the same salt, showing the magnitude of the discrepancies between parallel determinations.



We should state, however, that in this curve the figures for 0° and 100° were obtained with the utmost care by our method of work (raising the temperature, not lowering it), but *not* with aid of the apparatus—flasks having been used instead. This work was performed at the laboratory of Cornell University, and we owe many thanks to Prof. C. H. Wing, non-resident Professor of Chemistry at Cornell, for his kind and valuable suggestions regarding it.

Parts $Cu\,S\,O_4$ (anhyd.) soluble in 100 parts water.

At 0° C.	13.98	14.31	dif.. .33	At 60° C.	39.00	39.02	dif., .02
At 10° C.	17.34	17.65	" .31	At 70° C.	45.61	45.87	" .26
At 20° C.	20.58	20.49	" .09	At 80° C.	54.63	54.33	" .30
At 30° C.	24.37	24.32	" .05	At 90° C.	63.50	64.14	" .64
At 40° C.	28.50	28.50	" .00	At 100° C	75.18	75.26	" .08
At 50° C.	33.34	33.32	" .02				

RARE FORMS OF FISH IN KANSAS.

BY B. F. MUDGE.

About a year ago, there were sent to Hon. Alfred Gray, of Topeka, two fragments of fish jaw, without any statement of where they were found. The singular and unusual appearance of the teeth attracted my attention, and gave me not a little study to fix their relation to other fossils. Being at Osage City soon after, I procured two similar specimens, and learned that those of Topeka were from the same locality. The jaws were from a Cestraciont Selachian—entirely new to science. It is well known that the shark tribe, to which these belong, have no solid bones or any solid substance in the body, except the teeth; and consequently the latter are the only parts of the body ever fossilized, or which now remain to give us a knowledge of their structure and habits. As the jaws are cartilaginous, when the animal dies the ligaments holding the teeth together decay, and they become separate, and are not found in regular position. In the present case they are found in their natural and regular position. The jaws must have become imbeded in a firm clay, which retained the teeth together, after the cartilage decayed. The teeth being palatal, or pavement, covered the whole surface of the mouth, instead of being arranged in rows at the edge of the jaws, and we now have them in their natural arrangement. Many of the Cestracionts have no order in the position of their teeth; but in this specimen the rows are very regular, and must have numbered five hundred and sixty (560) in a single jaw. The largest teeth—two and a half inches in basal length—are found in the center of the mouth, and diminish in size as they approach the front; and the teeth also lessen in number toward the sides of the mouth. The best specimen contained over four hundred teeth in excellent order and preservation. A portion of one side of the jaw was gone, but the regular position of the remaining teeth was such that the number and situation of the missing one hundred and sixty (160) were easily calculated.

Knowing the value and importance of the specimen, I immediately wrote to Prof. O. St. John, who makes a specialty of the carboniferous fishes, in the museum of Cambridge, under Agassiz. He requested a specimen for study. He writes me that the jaw is remarkable, in showing teeth so unlike in different rows that paleontologists, when finding them separately, have described the teeth now in one as belonging to two genera and three species. He also

adds that the lamented Agassiz stated on one occasion that if ever a perfect jaw of these ancient, extinct Cestracionts should be discovered, it would be found that several species now separated constitute but one. Thus ever true to nature was this great naturalist. He finds that these Cestraciont jaws throw much light on the earliest fossil fish, and the lowest type of fish of the present day. The affinities in this case are so different from what was previously known, that he has considered it a new genus and named it after Prof. Agassiz — Agazodus.

The most remarkable species of fish which we have found, the present season, are of a genus new to me, and I think to science. They are armed with a long, strong weapon at the extremity of the upper jaw, something like that of a sword-fish, but round and pointed and composed of strong fibres. The jaws are provided with three kinds of teeth. On the outer edge is a row of large, flat, cutting teeth, somewhat resembling those of a shark. Inside, and placed irregularly, are small, blunt teeth; while in the back portion of the palate is the third set—small, sharp and needle-like in shape, forming a pavement. The jaws are also fibrous, like the shout. There are three species of this genus. Prof. Marsh has them for critical scientific examination.

REPORT ON BOTANY, 1874.

BY JAMES H. CARRUTH.

It would be very queer if, when we gave a man's name, we were obliged to give also the name of the person who gave him his name. But this is the way — I suppose properly — in Botany, and I have to acknowledge not having attended to this in my reports hitherto. Nor can I do it throughout in the present. If, at a future day, I am able to embody all the reports in one, I will try to do it.

I have not done much in the field the past year—partly from the pressure of other duties, but more because I have had my hands full of indoor work in this department, as will appear. Had I had more time, only the gleanings remained in Douglas county.

Last spring I sent to several persons copies of the reports already published, asking them to collect specimens of rare species, and also to make lists of such as they found, not already published.

The additions this year have come largely in this way. Prof. Snow, with the help of his students and correspondents, has furnished

more than twenty. Miss M. P. Wright, of Burlington, has brought me specimens of three — two of them common at the east, but not hitherto found in Kansas. Miss E. C. Wright, living near Irving, Marshall county, has sent me a list of forty or fifty, of which she feels certain, but her specimens have been accidently spoiled. Mr. E. A. Popenoe, of Topeka, has made a trip to Western Kansas, and has given me a list of more than forty found there and at home. Dr. L. Watson, of Ellis, has sent me plants all summer—more than I have found time to analyze. Indeed, the plants of Western Kansas are so different from those east of the Mississippi—the field of Wood and Gray—that I could not have done much with them, had not Dr. W. kindly put me in the way to get Porter & Coulter's Flora of Colorado; and even with this aid, the work has been slow, because dried specimens, especially of small plants, are much more difficult to analyze than fresh ones. Stamens and pistils often afford no aid, and the form of the flower is often spoiled. Still I think I have succeeded with most that I have tried, and am very sorry that I could not have tried all. If I or those who have reported to me have made mistakes, we will try to have all made right in the final summing up.

Our previous lists have made over 800. The lists given me this year are in part the same, but make in all about 140 different ones. Porter & Coulter give, as the result of the observations of some six to ten botanists in Colorado, about 1,050 species, including the lilies and one or two other small orders of cryptogamia. Mr. N. Colman has published a Flora of Southern Michigan, and his catalogue contains 1,375 copies, including as above.

Prof. Wood's Class Book describes about 3,900 species growing east of the Mississippi, a large proportion being found in the South Atlantic and Gulf States.

In view of these facts, I think we may expect to find in Kansas about 1,200 species. I have mentioned Porter & Coulter. I would recommend to Kansas botanists, specially at the west, to procure their work. It may be had by writing to the Department of the Interior, and sending a dime or two to pay postage. The species not in Gray's Manual are described fully. Generic descriptions, outside of Gray, are also given. The genera not in Gray are 94, and the species over 600.

The tendency is quite strong of late to consider some forms of plants which have been hitherto regarded as species as only varieties. I think it will require long and close observation to determine some questions of this kind. Animals in their wild state, are but little

UMBELLIFERAE.

Chærophyllum.

C. procumbens Lam. Lawrence and Topeka. Popenoe.

CORNACEAE.

Cornus, Dogwood.

C. stolonifera Mx. Irving. Miss E. C. W.

RUBIACEAE.

Galium, Bedstraw.

G. circæzans Mx. Salina. J. Henry.

Houstonia, Bluets.

H. angustifolia Mx. Irving. Miss E. C. W. Also Ellis. Watson.

COMPOSITAE.

Liatris.

*L. ———. Ellis. Watson.

Eupatorium, Boneset.

E. parviflorum Ell. Irving. Miss E. C. W.

Solidago, Goldenrod.

*S. pumila T. and G. Ellis. Watson.
S. lanceolata Ait. Irving. Miss E. C. W.
S. gigantea Ait. Irving. Miss E. C. W.

Rudbeckia, Cone-flower.

R. laciniata L. Irving. Miss E. C. Wright.

Helianthus, Sunflower.

H. annuus L. Irving. Miss E. C. W.
H. tuberosus L. Lawrence. Also Irving, Miss E. C. W.

Actinomeris.

A. helianthoides Nutt. Irving. Miss E. C. W.

Gaillardia.

G. ———. Dodge. Popenoe.

Hymenopappus.

H. tenuifolius Psh. Salina. J. Henry.

Helenium.

H. tanacetifolium. W. Kansas. Popenoe.

Artemisia, Wormwood.

A. frigida Willd. Irving. Miss E. C. W.
A. biennis Willd. Irving. Miss E. C. W.

Senecio, Groundsel.

*S. longiloba. Ellis. Watson.

Cirsium, Thistle.

*C. undulatum. Western Kansas, Popenoe. Also Salina, Henry.

Lygodesmia.

*L. juncea. Western Kansas. Popenoe.

Mulgedium, Wild Lettuce.

M. Floridanum DC. Lawrence. Also Ellis, Watson.

ERICACEAE.

Monotropa, Indian Pipe.

M. uniflora Retz. Ellis. Watson.

PRIMULACEAE.

Androsace.

A. filiformis. Ellis. Watson.

PLANTAGINACEAE.

Plantago, Plantain.

P. pusilla Nutt. Salina. J. Henry.
P. aristata (a dwarf var.) Ellis. Watson.

OROBANCHACEAE.

Aphyllon.

A. fasciculatum T. & G. Irving. Miss E. C. W.

SCROPHULARIACEAE.

Pentstemon, Beard-tongue.

P. gracilis Nutt. Lawrence.

Mimulus, Monkey-flower.

M. Jamesii Torr. Irving. Miss E. C. W.

Veronica, Speedwell.

V. Americana Schw. Irving. Miss E. C. W.

Gerardia.

G. purpurea L. Irving. Miss E. C. W.

Castilleja.

C. sessiflora Ph. Salina, J. Henry. Also Ellis, Watson.

VERBENACEAE.

Verbena, Vervain.

*V. bipinnatifida. Ellis. Watson.

Lippia.

L. cuneifolia. Dodge. Popenoe.
L. lanceolata. Ellis. Watson.

LABIATEAE.

Lycopus.

L. Virginicus L. Irving. Miss E. C. W.

Salvia, Sage.

S. angustifolia. Lawrence. Snow.

Scutellaria, Skullcap.

S. lateriflora L. Lawrence. Snow.
*S. racemosa Torr. Ellis. Watson.

BORRAGINACEAE.

Echinospermum.

E. lappula. Irving, Miss E. C. W. Also Lawrence, Snow.

POLEMONIACEAE.

Phlox.

P. Carolina. Irving. Miss E. C. W.

CONVOLVULACEAE.

Ipomœa.

I. leptophylla Torr. Hutchinson. Popenoe.

Calystegia.

C. Catesbiana Ph. Irving. Miss E. C. W.

Cuscuta, Dodder.

C. arvensis var. Irving. Miss E. C. W.

ASCLEPIADACEAE.

Asclepias, Milkweed.

*A. speciosa. Hutchinson. Popenoe.
*A. Jamesii Torr. Ext. W. Kansas. Popenoe.
A. verticillata (a dwarf variety.) Ellis. Watson.

Enslenia.

E. albida Nutt. Irving. Miss E. C. W.

POLYGONACEAE.

Rumex, Dock.

R. verticillatus L. Irving. Miss E. C. W.

CHENOPODIACEAE.

Chenopodium, Goosefoot.

C. glaucum. Irving. Miss E. C. W.
C. Boscianum. Irving. Miss E. C. W.

AMARANTACEAE.

Amarantus.

A. blitum L. Lawrence. A common weed described in Eaton, and in the old edition of Wood, but omitted in later editions, and in Gray.

EUPHORBIACEAE.

Euphorbia, Spurge.

S. obtusata Ph. Irving. Miss E. C. W.

Croton.

C. ——— undetermined. Ellis. Watson.

CALLITRICHACEAE.

Callitriche.

C. verna L. Ellis. Watson.
C. autumnalis L. Irving. Miss E. C. W.

PODOSTEMACEAE.

Podostemum.

P. ceratophyllum Mx. Lawrence.

CERATOPHYLLACEAE.

Ceratophyllum.

C. demersum L. Ellis. Watson.

CUPULIFERAE.

Ostrya, Ironwood.

O. Virginica Willd. Fort Leavenworth. F. Van Vliet.

ARACEAE.

Pistia.

P. Stratiotes L. Ellis. Watson.

Arisæma.

A. quinatum. Irving. Miss E. C. W.

LILIACEAE.

Yucca.

Y. angustifolia Ph. W. Kansas. Popenoe.
Y. filamentosa. Salina. J. Henry.

PONTEDERIACEAE.

Pontederia, Pickerel Weed.

P. cordata. Burlington. Miss M. P. Wright.

JUNCACEAE.

Juncus.

J. repens Mx. Ellis. Watson.

CYPERACEAE.

Cyperus, Sedge.

C. erythrorhizos Muhl. Lawrence.
C. dentatus Torr. Lawrence. Snow.
C. Schweinitzii. Lawrence. Snow.

Carex.

C. Muhlenbergii. Lawrence. Snow.
C. Schweinitzii. Irving. Miss E. C. W.
C. Pennsylvanica Lam. Irving. Miss E.C.W.
C. argyrantha Tuckm. Irving. Miss E.C.W.
C. sparganoides Muhl. Irving. Miss E.C.W.
C. setacea Dew. Irving. Miss E. C. W.
C. oxylepis Torr. Irving. Miss E. C. W.
C. blanda Dew. Irving. Miss E. C. W.
C. gracillima Schw. Irving. Miss E. C. W.
C. conoidea Schk. Topeka. Popenoe.
*C. alboluteus. Topeka. Popenoe.

GRAMINEÆ.

Alopecurus.

A. aristulatus Mx. Salina. J. Henry.

Paspalum.

P. sanguinale Lam. Lawrence.

Tricuspis.

T. acuminata. Dodge. Popenoe.

Festuca, Fescue Grass.

F. tenella Willd. Topeka. Popenoe.
F. nutans Willd. Topeka. Popenoe.

Poa.

P. trivialis. Leavenworth. Wherrell.

Brizopyrum.

B. spicatum Hook. W. Kansas. Popenoe.

Hordeum, Barley.

H. jubatum L. Irving. Miss E. C. W.

Elymus, Wild Rye.

E. striatus Willd. Lawrence.

Triticum, Wheat.

T. repens var. W. Kansas. Popenoe.

Bouteloua.

B. hirsuta Lag. Dodge. Popenoe.

Erianthus.

E. brevibarbis Mx. Irving. Miss E. C. W.

Species, about 140; not in class book, 45.

Several species of grasses are not enumerated in this catalogue for want of time to determine them.

LAWRENCE, December, 1874.

OBSERVATIONS ON THE USE OF THE ANTENNÆ OF POLYPHYLLA VARIOLOSA, HARRIS.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

Penikese Island, the site of the Anderson School of Natural History, is one of the group known as the Elizabeth Islands, situated about half way between Martha's Vineyard and the city of New Bedford, some sixteen miles from each of these localities. This almost barren island contains about eighty acres of land, and is entirely destitute of shrubs and trees, thus affording a very unpromising collecting-ground for an entomologist.

While walking over the eastern elevation of the island, after sundown, on July 13, the writer obtained two or three specimens of an insect belonging to the Scarabæan family of Coleoptera, described by Harris as *Melolontha variolosa*, but now referred to the genus *Polyphylla*. Harris speaks of this beetle as "occurring abundantly in the month of July at Martha's Vineyard, and in some other places near the coast;" but as "rare in other parts of Massachusetts." In general appearance, mode of development, and habits, it resembles the common May beetle, *Phyllophaga fusca*, Frohl. The larva and pupa stages of its existence are spent in the ground. The imago is reddish brown, marked above with obscure whitish stripes on account of which Harris styled it "the scarred Melolontha." Like the May beetle, it flies abundantly at dusk and during the evening. It differs from the various species of *Phyllophaga*, however, in the remarkable structure of its antennæ, the "club" of which is composed of seven broad ligulate plates or leaves. These antennal plates have a much greater development in the male than in the female, so that the sexes may be readily distinguished at a considerable distance.

It is one of the most curious discoveries of recent investigators into the physics of entomology, that an exceedingly delicate auditory apparatus exists in the antennæ of many insects. At the meeting of the National Academy of Sciences in November, 1873, Prof. A. M. Mayer described a series of experiments upon the antennæ of the male mosquito. Placing one of these insects alive upon the stage of his microscope, he observed the effects produced upon the numerous sensitive fibrillæ with which the joints of the antennæ are provided. By bringing a vibrating tuning-fork into close proximity to the mosquito, he observed that certain of the fibrillæ were thrown into rapid motion, while the rest were comparatively motionless. Substituting a second tuning-fork, sounding a different note, the first

series of fibrillæ remained motionless, while a second series was thrown into rapid vibration. The experiment was continued with tuning-forks of still other tones, with similar results. Prof. Mayer thus made the discovery that the fibrillæ of the mosquito's antennæ are tuned by nature to vibrate in sets in unison with sounds of different quality.

In the antennal plates of *Polyphylla variolosa* no fibrillæ are present, but the surfaces of these plates are furnished with innumerable minute vesicles, each of which is provided with a nerve to communicate the vibrations received by the vesicle from the sounding body.

The use of the antennæ of the male mosquito is undoubtedly to guide him to his mate, whom he must find in the dark. Prof. Mayer has shown that the song of the female mosquito has the power of vibrating the fibrils of the antennæ of the male in such a way as to enable him to direct his flight in a straight line to the object of his search. In the case of *Polyphylla variolosa* I believe that the male antennæ have a similar function, and that these organs in the genus have a development so far surpassing other genera of the group to which it belongs, on account of the peculiarly difficult circumstances under which the male discovers the whereabouts of the female.

Two days after securing my first specimens of this beetle, at dusk July 15th, 1874, I visited the same spot and found these insects so abundant that upwards of fifty specimens were obtained in a quarter of an hour. On this occasion, though pleased to obtain so much material for cabinet and laboratory uses, I was especially gratified in observing the actions of the males in searching for their mates. My attention was first arrested by a male vigorously scratching the ground with his feet while his antennæ were fully extended with their antennal plates widely separated. His progress being too slow to suit my purpose, I assisted him in his excavation, and at a depth of half an inch discovered a female who, with head upwards, was struggling to reach the surface, having evidently but just emerged from the pupa. A little further on another male was busily scratching the soil, and another female was unearthed directly underneath, while a moment later two rival males were discovered digging for a third female who was buried nearly an inch below the surface.

Two or three evenings later I visited the same spot, but found the pairing season evidently over, only two or three single specimens rewarding my search. But the repeated observations of July 15, have convinced me that the male antennæ of *Polyphylla variolosa* have an excessive development in size, and an extreme sensibility to sound vibrations in order to enable them to ascertain the position of their mates while yet buried in the ground.

METEOROLOGICAL SUMMARY FOR THE YEAR 1874.

PROF. F. H. SNOW'S ANNUAL REPORT.

Station, Lawrence, Kansas. Latitude 38° 58′; longitude 95° 16′. Elevation of barometer and thermometers, 884 feet above the sea level and 14 feet above the ground; rain gauge on the ground; anemometer 105 feet above the ground, on the dome of the University building.

TEMPERATURE.

Mean temperature of the year, 54°.2, which is 1°.25 above the mean of the six preceding years. The highest temperature was 108°, on the 5th of August; this being 4° higher than any previous observation on our seven years' record. The lowest temperature was 3° below zero, on the 29th of December; this being 2° higher than any previous annual minimum on our record. Mean temperature at 7 A. M., 47°.88; at 2 P. M., 62°.49; at 9 P. M., 50°.18.

Mean temperature of the winter months, 28°.88—0°.08 above the average; of the summer, 80°.92—4°.53 above the average; of the autumn, 53°.92—1°.62 above the average.

The coldest month of the year was February—the coldest February on our record—with mean temperature 27°.5; the coldest week was February 20th–26th, with mean temperature 19°.24; the coldest day was December 29, with mean temperature 7°.3. The mercury fell below zero but twice—January 3 and December 29.

The hottest month of the year was July, with mean temperature 83°.62; the hottest week was July 19th–25th, mean temperature 89°.33; the hottest days were August 5 and 11, which each had a mean temperature of 94°. The mercury reached or exceeded 90° on 58 days, viz.: 4 in May, 6 in June, 21 in July, 24 in August, and 3 in September. There were 9 days on which the mercury reached or exceeded 100°, viz.: July 24, 25, and August 5, 9, 10, 11, 12, 13 and 17.

The last light frost of spring was on April 23; the first light frost of autumn was on September 15, giving a period of 145 days entirely without frost. The last severe frost of spring was on April 9; the first severe frost of autumn was on October 23, giving a period of 207 days without severe frost. No cold weather during the year caused any damage to fruit.

RAIN.

The entire amount of rain, including melted snow, was 28.87 inches, which is the smallest annual rainfall on our seven years' record, and falls below the average rainfall of the past six years by 5.48 inches. Either rain or snow fell on 99 days, 4 less than the

average number. The longest interval without rain during the growing season, March 1 to October 1, was 15 days, from July 23 to August 9. The number of thunder showers was 20. The marked deficiency in the rainfall of July and August resulted in great damage to the crops in all parts of Kansas, and produced the only severe and extended drouth since 1860. The amount of excess or deficiency in the rainfall of each month of the year is indicated in the table appended to this report.

SNOW.

The entire depth of snow was 43 inches, distributed as follows: January, 7½ inches; February, 10 inches; March, 4 inches; November, 14 inches; December, 7½ inches. The last snow of spring was on April 16; the first autumn snow was on November 17. The annual amount of snow, as given above, is 20.58 inches above (nearly double) the average for the six preceding years.

FACE OF THE SKY.

Average cloudiness of the year 45.54 per cent. of the sky, which is only 0.06 per cent. below the average. The number of clear days (less than one-third cloudy) was 155; half clear days (between one-third and two-thirds cloudy) 108; cloudy (more than two-thirds) 102. There were 27 days without a cloud, and 30 days without a trace of sky. August was the clearest month, with a mean cloudiness of 24.95 per cent. March was the cloudiest month, mean cloudiness, 62.27 per cent. The mean cloudiness at 7 A. M. was 50.79 per cent.; at 2 P. M. 48.82 per cent.; at 9 P. M. 37 per cent.

DIRECTION OF THE WIND.

During the year (three observations daily) the wind was from the southwest, 335 times; northwest, 224 times; northeast, 190 times; southeast, 142 times; south, 76 times; north, 54 times; east, 42 times; west, 8 times; calm, 24 times. The south (including southeast, south and southwest) winds outnumbered the north (including northeast, north and northwest) winds in the ratio of 553 to 468.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 145,865. This gives a mean daily velocity of 399.6 miles, and a mean hourly velocity of 16.62 miles. The position of the anemometer cups at an elevation of 105 feet above the ground, the most elevated point for many miles in all directions, secures exposure to the full force of the wind. The maximum velocity attained was 65 miles an hour on September 18. The greatest daily velocity was 1,061 miles on January 3. The strongest winds were in April and November; the lightest were in February and June.

BAROMETER.

Mean height of the barometer column, 29.121 inches. Mean at 7 A. M., 29.146 inches; at 2 P. M., 29.096 inches; at 9 P. M., 29.121 inches; maximum, 29.845 inches, at 7 A. M., January 24; minimum, 28.267 inches, at 2 P. M., November 22, this being the lowest reading on our record except that of January 16, 1870, 28.191 inches; yearly range, 1.578 inches. The highest monthly mean was in December, 29.235 inches; the lowest was in May, 29.027 inches. The barometer observations are corrected for temperature, but not for elevation, thus affording the means of determining the altitude of our station.

RELATIVE HUMIDITY.

Mean for the year, 65.52; at 7 A. M., 76.5; at 2 P. M., 49.18; at 9 P. M., 70.87. The dampest month was December, humidity 79.4; the driest month was August, humidity 49.02. There were 14 fogs during the year.

FORCE OF VAPOR (IN INCHES).

Mean for the year 0.319; at 7 A. M., 0.317; at 2 P. M., 0.310; at 9 P. M., 0.329; greatest, 0.863, at 9 P. M., July 30; least, 0.038 at 7 A. M. December 29; highest monthly mean in June, 0.603; lowest in January, 0.121.

The following table gives the mean temperature, the extremes of temperature, the relative humidity, and the rainfall for each month of the year 1874; also a comparison with preceding years:

Month.	Mean Temperature.	Max'm Temperature.	Min'm Temperature.	Relative Humidity.	Rainfall in Inches.	Excess or Deficiency of Rainfall.
January	28.01	61.0	—2.5	73.07	2.35	*1.04
February	27.50	49.0	2.0	78.21	0.95	†0.01
March	39.50	69,5	19.0	67.12	2.30	*0.23
April	48.07	83.0	22.5	57.73	2.86	†0.14
May	69.76	95.0	45.0	55.60	1.41	†2.68
June	77.11	95.0	53.5	66.02	3.58	†0.01
July	83.62	103.0	68.0	52.15	1.19	†3.96
August	83.45	108.0	65.0	49.02	1.00	†3.97
September	67.03	94.0	41 0	71.70	6.45	*3.23
October	56.01	89.0	19.5	67.20	1.92	†0.69
November	38.76	77.5	5.5	72.47	3.69	*2.08
December	31.01	55.5	—3.0	79.40	1.17	†0.58

* Excess. † Deficiency.

COMPARISON WITH PRECEDING YEARS.

Year.	Mean Temp.	Max. Temp.	Min. Temp.	Relative Humidity.	Rainfall in Inches.
1874	54.20	108.0	—3.0	65.52	28.81
1873	52.71	104.0	—26.0	64.06	32.94
1872	51.90	97.0	—18.0	64.40	32.63
1871	54.30	103.0	—6.0	.....	33.23
1870	54.50	102.0	—10.0	68.40	31.38
1869	50.99	96.0	—5.0	.....	38.51
1868	53.36	101.0	—16.5	.....	67.42